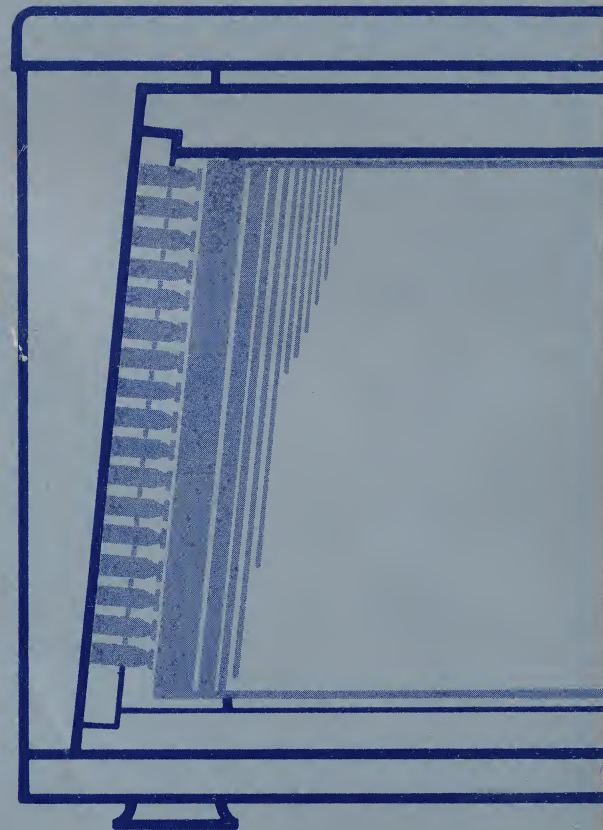


TECHNICAL DATA



AUTO-LIFT MAGNETIC STORAGE DRUMS

BRYANT

COMPUTER PRODUCTS

A DIVISION OF EX-CELL-O CORPORATION

Bryant Auto-Lift + Uni-Just Aerodynamic Heads

AUTO-LIFT MECHANISM

Bryant Computer Products—the largest independent supplier of memory drums—has produced thousands of magnetic storage drums to satisfy both standard and custom requirements in prototype and production quantities. Bryant drums have established an enviable reputation for mechanical excellence, high quality, and reliability at low cost, and have for many years featured patented tapered rotor (truncated cone) construction for ease of head adjustment and maintenance.

In response to computer industry demands for even greater reliability, higher bit density, faster bit rates, and lower cost per bit, Bryant research has developed a flying head drum with Auto-Lift—the ultimate in reliability and maintainability. They have combined the time-proven, Bryant-patented tapered drum with true aerodynamic heads to produce the first simple, fail-safe drum design that eliminates head contact.

Bryant engineers achieved their goal without the use of auxiliary motors, cables, cams, solenoids, or bi-metal components. By designing and developing a simple, self-regulating automatic device for moving the drum along its axis, Bryant engineers have made it possible for the magnetic surface to be brought up to, but not into contact with, the heads during start-up and to be retracted from the heads when stopping. When the drum speed is insufficient to generate a laminar film of air capable of supporting the heads aerodynamically, the drum descends away from the heads. This results in extremely reliable clearance between head and drum surfaces.

HERE'S HOW AUTO-LIFT WORKS—

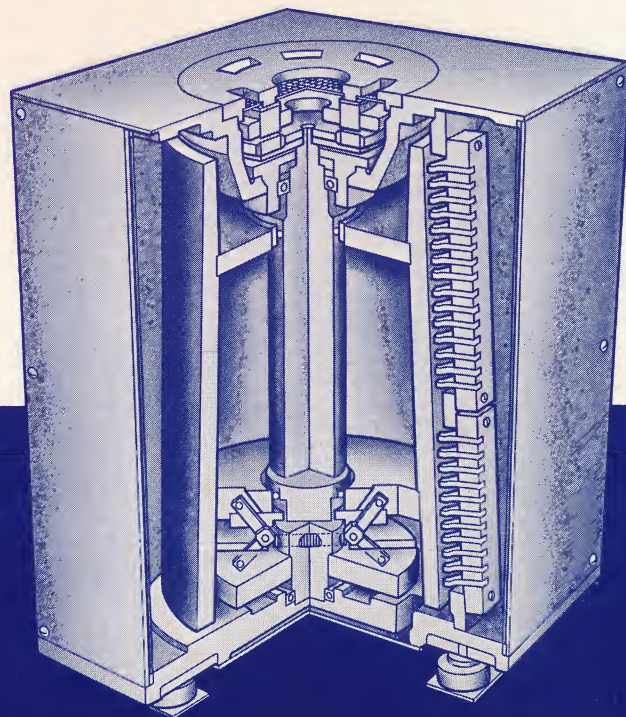
In the static condition, the flying heads are located away from the surface of the tapered drum. The mechanism for moving the drum axially comprises a pair of simple scissor links which are straightened out by centrifugal force as the drum accelerates to approximately 75% of its operating speed. Straightening of the links raises the drum against a precision stop which defines its operating position. Thus, repeatability of track location is *exact*. Spring tension is used to col-

lapse the links and lower the drum as it slows down to approximately 65% of operating speed.

This unique centrifugal mechanism, resembling a fly ball governor, is used in all Auto-Lift drums and functions automatically without operating adjustments for the life of the drum. No auxiliary motors, actuators or external control mechanisms are required, and the unit is largely insensitive to thermal and physical shock.

The Auto-Lift principle used in Bryant drums offers the following exclusive features:

- No head/drum contact.
- Centrifugal lift raises tapered drum to heads at operating speed.
- Tapered drum retracted axially on stop cycle.
- Simple, fail-safe operation regardless of number of heads.
- Auto-Lift maintains head-to-drum spacing.
- Auto-Lift is automatic, requires no external power, controls, or adjustment.
- Auto-Lift unit relatively unaffected by temperature, shock, or vibration.
- Full range of standard sizes and speeds in production.
- Interchangeable production parts throughout.
- All drums expandable to full capacity in field.
- Motor and bearings field servicable without loss of data.



Cross-sectional view of a typical Auto-Lift magnetic storage drum.



Functional diagram showing how Bryant's Auto-Lift mechanism operates. In the stopped—or drum down—position (A), the heads are located about 0.010 inch from the drum surface to ensure against start/stop contact. When the drum moves to its up position (B), the heads are supported on a laminar film of air created by drum rotation.

= Reliability and Maintainability

UNI-JUST AERODYNAMIC HEAD

Total drum system reliability depends not only upon the ability of the drum to operate without head-to-drum contact during start/stop cycles, but also on the ability of heads to fly over a wide range of operating conditions and on the electromagnetic performance of the heads.

Bryant Uni-Just flying heads are truly aerodynamic. They fly stably at all Auto-Lift operating speeds, and over a wide range of shock, vibration, and temperature conditions. Uni-Just heads fly continuously—without skipping or bouncing. Playback signal modulation is virtually eliminated.

The Uni-Just head consists of a pole piece structure encased by a magnetic shield and molded in an aerodynamic pad, as shown in upper figure. A single mechanical design serves all of the standard Auto-Lift drums throughout their speed ranges, simplifying maintenance and reducing cost of production and spare parts inventory.

All magnetic heads exhibit a natural distribution of characteristics. Variations in playback amplitude are compensated for by adjusting the flying positions of the individual heads relative to the drum surface. A wide range of head adjustment is available because of the extremely stable flying characteristics.

Adjustments are achieved by varying the head preload toward the drum while the drum is rotating. This adjustment is made against a spring mounted in each head body and is locked by a screw. The spring provides fail-safe operation by retracting the head from the drum in the event the set screw is loosened inadvertently.

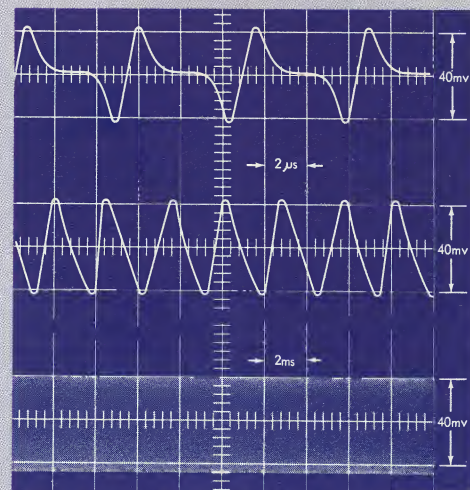
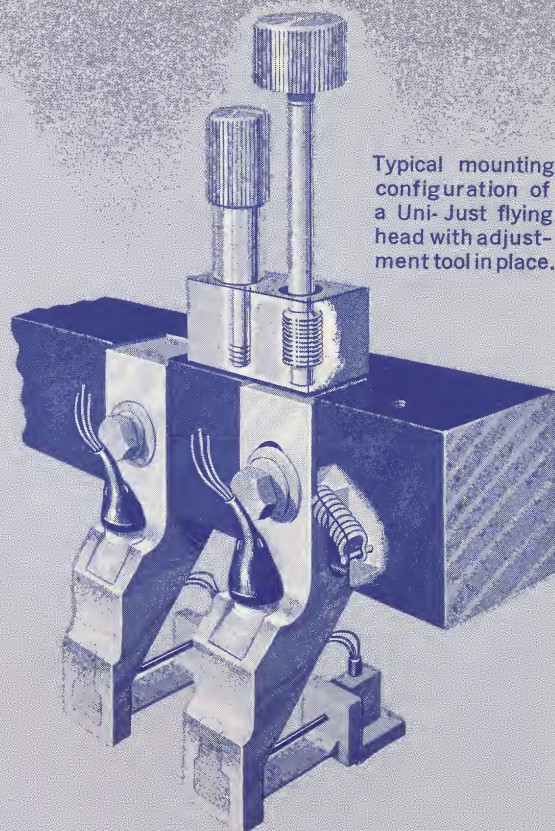
These superior head features—coupled with the excellent electrical characteristics of Uni-Just heads—produce a standard of performance which is outstanding in terms of resolution, amplitude uniformity, frequency range and reliability. Low-frequency/low-density and high-frequency/high-density (over 500 ppi) applications requiring selective bit alteration or bit interlacing are handled with equal reliability.

Individual head adjustment is easily made with a simple tool while the drum is operating, as shown in the lower figure. While the head is being set, an oscilloscope monitoring the write-read operations displays a smooth envelope when the head is flying on the laminar film of air created by the drum rotation, as shown in the center figure. When the desired playback is achieved, the locking screw is tightened and the tool removed. To make this adjustment procedure completely fail-safe, the adjustment slot in the head bracket is designed to prevent the free end of the head bracket from contacting the drum.

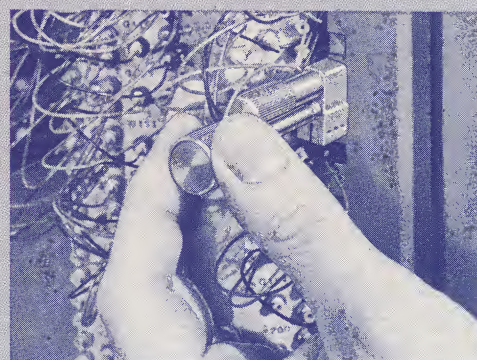
Bryant Uni-Just Aerodynamic Heads used on all Auto-Lift drums offer the following features:

- True aerodynamic heads fly continuously—no skipping or bouncing.
- Negligible playback envelope modulation.
- Fail-safe individual adjustment of heads.
- Head adjustment and replacement with drum running.
- Full range of frequency and pulse density satisfied by production heads.
- Unlimited recording modes.

Typical mounting configuration of a Uni-Just flying head with adjustment tool in place.



Unretouched oscilloscope display showing playback signal level and resolution for a pattern of alternate ONES and ZEROS (top-waveform) and all ONES (middle waveform). The lack of modulation of the overall envelope (bottom waveform) indicates head is truly flying and not "bouncing" or "skipping" along.

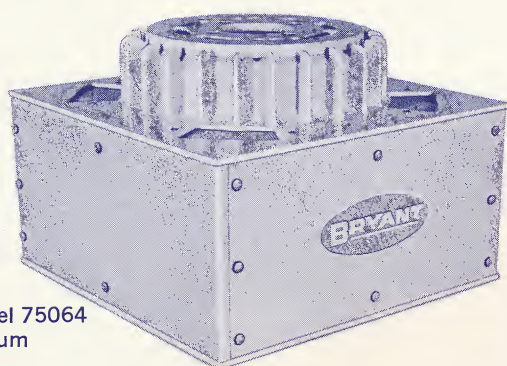


Uni-Just head being set using special adjustment tool.

STANDARD AUTO-LIFT DRUMS

Recommended Maximum Recording Densities

Discrete-Bit Alteration—500 BPI
Block-Format—800 BPI



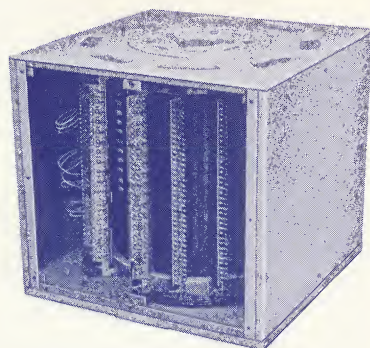
Bryant Model 75064
Auto-Lift Drum

SERIES 5000

- Average access times as low as 2.5 milliseconds
- Capacities up to 3,617,280 bits
- 5-Inch diameter, nominal

SERIES 75000

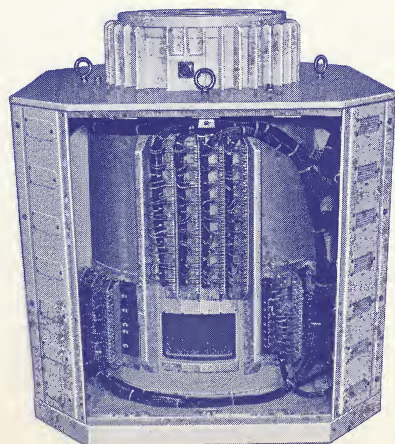
- Average access times as low as 5.0 milliseconds
- Capacities up to 5,425,920 bits
- 7.5-Inch diameter, nominal



Bryant Model 10256
Auto-Lift Drum

SERIES 10000

- Average access times as low as 6.7 milliseconds
- Capacities up to 14,469,120 bits
- 10-Inch diameter, nominal



Bryant Model 185384
Auto-Lift Drum

SERIES 185000

- Average access times as low as 8.35 milliseconds
- Capacities up to 47,587,330 bits
- 18.5-Inch diameter, nominal

AUTO-LIFT MODEL		5064		5128		5256					
PACKING DENSITY (BITS/INCH)		500 ¹	800 ²	500 ¹	800 ²	500 ¹	800 ²				
TRACK CAPACITY (BITS)		7,850	12,560	7,850	12,560	7,850	12,560				
NUMBER OF TRACKS		90	90	156	156	288	288				
DRUM CAPACITY (BITS)		706,500	1,130,400	1,224,600	1,959,360	2,260,800	3,617,280				
ACCESS TIMES ³ (MILLISECONDS) AT THESE STANDARD SPEEDS:											
3,600 RPM 16.7	} ONE REV	●	●	●	●	●					
4,000 RPM 15.0											
4,800 RPM 12.5											
6,000 RPM 10.0											
8,000 RPM 7.5											
12,000 RPM 5.0	} AVG	●	●	●	●	●					
OVER-ALL HEIGHT (INCHES) ^{4,5}		12½		15		20⅝					
OVER-ALL WIDTH (INCHES) ⁶		13¾		13¾		13¾					
APPROXIMATE WEIGHT (POUNDS)		75		90		120					
AUTO-LIFT MODEL		75064		75128		75256					
PACKAGING DENSITY (BITS/INCH)		500	800	500	800	500	800				
TRACK CAPACITY (BITS)		11,775	18,840	11,775	18,840	11,775	18,840				
NUMBER OF TRACKS		90	90	156	156	288	288				
DRUM CAPACITY (BITS)		1,059,750	1,695,600	1,836,900	2,939,040	3,391,200	5,425,920				
ACCESS TIMES ³ (MILLISECONDS) AT THESE STANDARD SPEEDS:											
3,600 RPM 16.7	} ONE REV	●	●	●	●	●					
4,000 RPM 15.0											
4,800 RPM 12.5											
6,000 RPM 10.0											
	} AVG	●									
OVER-ALL HEIGHT (INCHES) ^{4,5}		12½		15		20⅝					
OVER-ALL WIDTH (INCHES) ⁶		15¾		15¾		15¾					
APPROXIMATE WEIGHT (POUNDS)		90		100		140					
AUTO-LIFT MODEL		10128		10256		10384		10512			
PACKING DENSITY (BITS/INCH)		500	800	500	800	500	800	500	800		
TRACK CAPACITY (BITS)		15,700	25,120	15,700	25,120	15,700	25,120	15,700	25,120		
NUMBER OF TRACKS		156	156	288	288	440	440	576	576		
DRUM CAPACITY (BITS)		2,449,200	3,918,720	4,521,600	7,234,560	6,908,000	11,052,800	9,043,200	14,469,120		
ACCESS TIMES ³ (MILLISECONDS) AT THESE STANDARD SPEEDS:											
1,800 RPM 33.4	} ONE REV	●	●	●	●	●					
3,600 RPM 16.7											
4,000 RPM 15.0											
4,800 RPM 12.5											
	} AVG	●									
OVER-ALL HEIGHT (INCHES) ⁴		16¾		17¾		25¾		34¾			
OVER-ALL WIDTH (INCHES) ⁶		17¾		17¾		17¾		17¾			
APPROXIMATE WEIGHT (POUNDS)		155		160		250		265			
AUTO-LIFT MODEL		185128		185256		185384		185512		1851024	
PACKING DENSITY (BITS/INCH)		500	800	500	800	500	800	500	800	500	800
TRACK CAPACITY (BITS)		29,045	46,472	29,045	46,472	29,045	46,472	29,045	46,472	29,045	46,472
NUMBER OF TRACKS		156	156	288	288	440	440	576	576	1024	1024
DRUM CAPACITY (BITS)		4,531,020	7,249,630	8,364,960	13,383,930	12,779,800	20,447,680	16,729,920	26,767,870	29,742,080	47,587,330
ACCESS TIMES ³ (MILLISECONDS) AT THESE STANDARD SPEEDS:											
1,200 RPM 50.1	} ONE REV	●	●	●	●	●	●	●	●		
1,800 RPM 33.4											
3,600 RPM 16.7											
	} AVG	●									
OVER-ALL HEIGHT (INCHES) ⁴		19½		20½		33½		38¾		57¾	
OVER-ALL WIDTH (INCHES)		28¾		28¾		29¾		29¾		29¾	
APPROXIMATE WEIGHT (POUNDS)		325		350		600		800		1000	

(1) Discrete-bit alternation—PM or MRB recording mode. (2) Block-format—PM or MRB recording mode (packing density doubled with NRZ or NRZI recording mode). (3) Speeds and access times do not include motor slip. (4) Measured from base of drum vibration mounts to top of drum motor. (5) Allow approximately four inches additional height for 400-cycle motor. (6) Allow two and one quarter inches minimum clearance for connectors on one side of drum.

Engineering Data

CAPACITY—Nominal 500 bit-per-inch (BPI) packing density determines capacity and frequency for single-bit alteration recording mode. Bit interlacing permits reduction of frequency while maintaining drum storage capacity. Packing densities up to 800 BPI are obtainable using block-format recording. (See chart at right).

CLOCKS AND REGISTERS—Number of tracks indicated for each drum includes a minimum of 16 tracks for clocks and registers; additional tracks can be assigned as required. These 16 tracks can be utilized to give various combinations of clocks and registers. For example, assuming one write and one read head were used per register, configurations could be made up of eight clocks and four registers, two clocks and seven registers, and the like. Also, any two adjacent general storage heads can be replaced with one register head. Spacing is 0.300 inch; shorter spacing is available only on special orders. Standard adjustment of all registers is factory set at ± 1 bit from nominal unless otherwise specified when the drum is ordered. (Note: Customer electronics are required at the Bryant plant whenever special register adjustment is stipulated.)

ACCESS TIME—Standard Auto-Lift drums are available with access times ranging from 50.1 milliseconds (1200 RPM) to 5.0 milliseconds (12,000 RPM). (See selection chart above). Access times down to 1 millisecond (60,000 RPM) are available on special order.

RECORDING DATA—Signal characteristics for a Bryant Auto-Lift drum system are defined as follows:

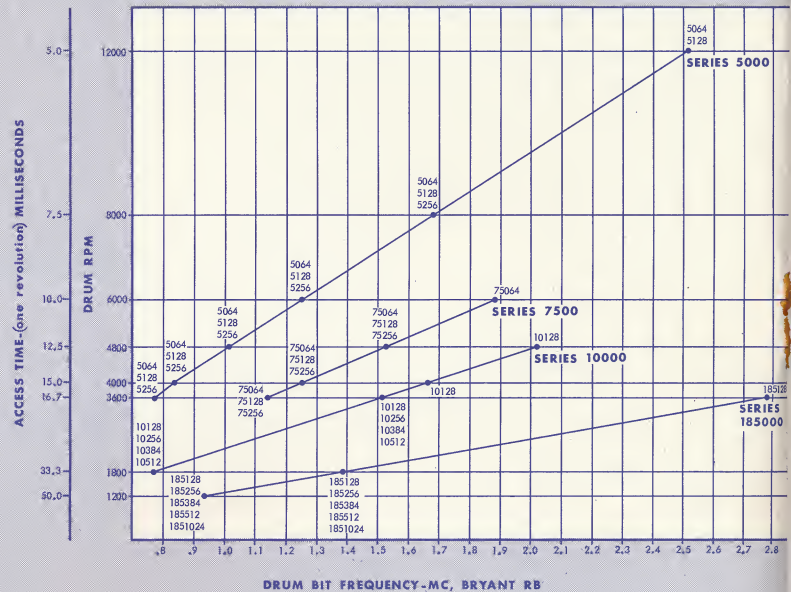
- Signal-to-noise-ratio is defined as the ratio of minimum all-ONE signals found anywhere on the drum to maximum noise after D-C erase.
- Head-to-head cross talk is defined as the ratio of a minimum signal to maximum noise while reading D-C erased track and simultaneously writing on the closest adjacent track.
- Modulation is calculated using the equation:

$$\% \text{ Modulation} = \frac{\text{Maximum Output} - \text{Minimum Output}}{\text{Maximum Output} + \text{Minimum Output}} \times 100$$

RECORDING MEDIA—Surfaces of standard Auto-Lift drums are plated with Bryant's super-finished, magnetic plating. This plating features:

- Low-friction, tough, abrasive-resistant surface.
- Extremely uniform playback and resolution characteristics over large drum surfaces.
- Low noise level.

MAGNETIC HEADS—Uni-Just aerodynamic heads are used to optimize drum performance through a broad range of operating frequencies and recording densities. Uni-Just heads are interchangeable and are adjusted with the drum in operation; thus heads may be replaced, if required, without taking the unit out of operation.



HEAD SPECIFICATIONS—Typical electrical and mechanical specifications for type AH020 Uni-Just Heads are as follows:

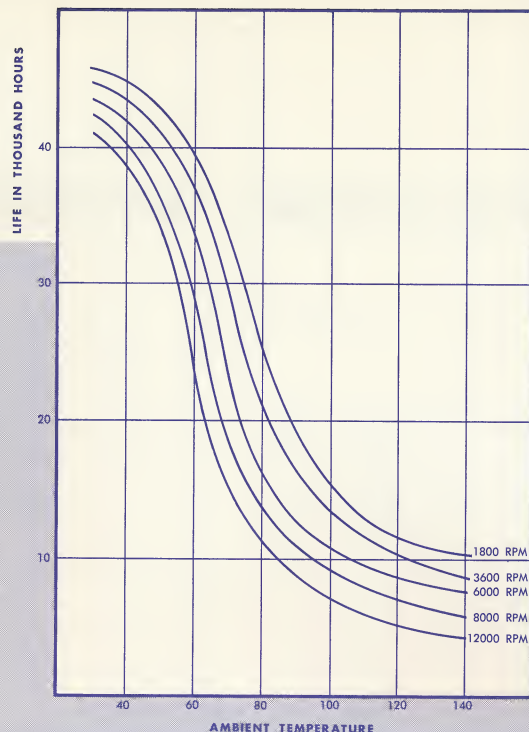
- Inductance (half coil)—17-24 microhenries at 140 kc
- D-C Resistance—1 ohm
- Drive Current—to fit application
- Balance (half coil -to- half coil)—10%
- Resonant Frequency (half coil)—3.8 megacycles, minimum
- Track Width 0.020 inch
- Track-to-Track Spacing—0.035 inch
- Surface Speed Limits—900 to 4500 inches per second

HEAD WIRING AND CABLING—All head leads are taper-pin connected to terminal boards mounted on the head bars. All clock connections from terminal boards to external connectors on drum covers are provided with shielded cable.

MOTORS—All Auto-Lift drums are available equipped with induction motors (synchronous motors are optional) which have been Bryant-designed exclusively for drum applications. For 1200, 1800 and 3600 RPM speeds, motors require 60-cycle, 115- or 220-volt, single- or three-phase power; all motors with speeds above 3600 RPM require 400-cycle, 115- or 220-volt, single- or three-phase power. Motor stators can be replaced in the field within 30 minutes without resetting heads or losing data.

BEARINGS—Grade ABEC-9 bearings made of vacuum melted steel—the finest production bearings available—are used as standard equipment on all Auto-Lift drums. Bryant drum bearings are grease lubricated at the factory with Andok "C" lubricant to give the longest possible lubricant life for the operating conditions and environment specified. Because of its unique design, Bryant Auto-Lift drums permit bearings to be replaced in the field within four hours without resetting heads or losing data. (See bearing chart above.)

Auto-Lift drum selection chart. Speeds and frequencies given do not include motor slip. Nominal 500 bit-per-inch packing density is used to determine frequencies shown; bit interlacing permits the reduction of frequency while maintaining capacity. Substantially higher packing densities can be obtained using block-format recording.



Average bearing lubricant life using standard Andok "C" grease. The curve was made using the largest Auto-Lift drum designed to operate at each speed shown.

ENVIRONMENTAL CAPABILITY*—All Auto-Lift drums will operate to performance specification within the following environmental limits:

- Temperature
 - Operating: +32° to +120°F (0° to 49°C).
 - Non-operating: -65°F to +160°F (-54°C to 72°C).
 - Thermal Shock: Drum with covers in place will withstand 50°F step change while in operation.
 - Humidity: Up to 95 % R.H.
- Altitude
 - Operating: to 15,000 feet
 - Storage: to 50,000 feet
- Shock and Vibration
 - Shock: 5 G's in any plane with standard mounts
 - Vibration:
 - 0-10 CPS (at 5 Mil excursion)
 - 10-25 CPS (at 2 Mil excursion)
 - 25-50 CPS (at 1 Mil excursion)
 - Over 50 CPS (at 0.5 Mil excursion with the maximum acceleration of 2 G's)

RELIABILITY:

- Design life is 100,000 hours when Bryant recommended preventive maintenance procedures are used.

PACKAGING:

- Quick access panels on all four sides
- Vertical mounting
- Dust tight enclosure

PRODUCT ASSURANCE—Bryant Product Assurance means assuring that delivered products fully satisfy the purchase specifications with regard to capability, reliability and quality. A complete Product Assurance organization reporting directly to general management has been established to carry out this function. The responsibilities of this organization begin during equipment design when reliability engineering personnel assist in development of hardware specifications and component selection. This early effort is followed by rigid quality control activity which assures that vendors and the fabricating departments fully comply with the specifications. Quality Control also enforces adherence to production and assembly procedures and conducts preliminary and final acceptance test of the deliverable equipment. Finally, the product assurance organization is responsible for operational failure analysis and the required feedback to design engineering.

ACCEPTANCE TESTS:

- All acceptance tests are run at Bryant facility unless otherwise negotiated.
- Tests are to standard Bryant test procedures unless otherwise negotiated.

SPECIAL TOOLS—Tools for head setting are provided with the drum at time of shipment.

MAINTENANCE AND INSTRUCTION HANDBOOK—Two copies of the standard Bryant maintenance and instruction handbook are provided with each drum.

FIELD SERVICE—In addition to regularly assigned field service personnel, Bryant factory personnel can be dispatched promptly to meet customer field service requirements.

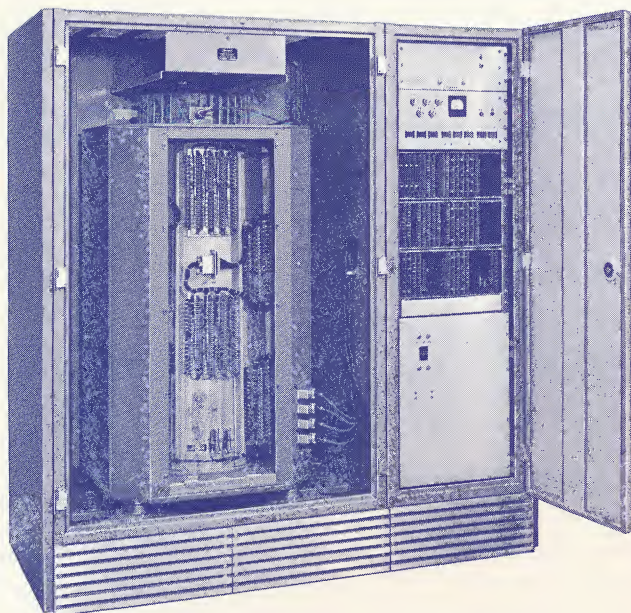
Service on Bryant drums and electronic systems can be obtained by contacting the Product Service Department at Walled Lake. Usually, servicemen are dispatched within 24 hours.

*Applies to standard units only. Drums meeting military requirements are available.

COMPLETE DRUM SYSTEMS—

Custom-designed memory systems—using standard circuit modules—can be built to give as much capability as desired, compatible with the memory equipment specified. Bryant will design an entire system around the customer's interface specifications of data rates, capacity, control signals, and modes of operation.

Simple systems incorporating only read, write and select amplifiers or more complex systems containing all address decoding, counters for address control and selection, shift registers for serial-to-parallel and parallel-to-serial conversion, and parity generation and checking can be readily designed and fabricated. Systems have been delivered which utilize up to 50-bit parallel recording, precession loops, and bit interlacing and discrete-bit alteration up to packing densities of 500 bits per inch. Phase modulation, RZ and return-to-bias recording systems are available.



ELECTRONIC COMPONENTS

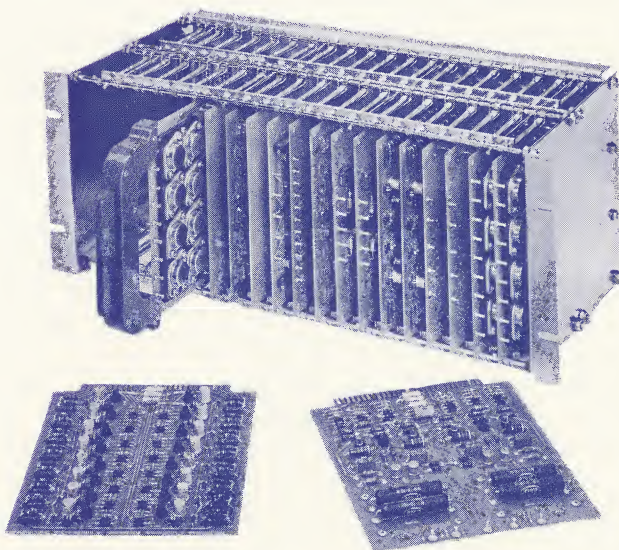
Bryant standard electronic modules are available to perform all of the read, write, clocking, head switching and logic functions required of a magnetic drum memory system. All are transistorized printed circuits mounted on glass epoxy cards; only the highest quality components are used.

Logic circuits are designed for 1 MC operation with rise and fall times less than 100 nanoseconds. All circuits have been worst-case designed for operation to temperature extremes from 0° to 55°C. Gold-plated connector tabs and connectors are used to ensure that all connections have maximum immunity to corrosion and minimum contact resistance.

Modules presently available include:

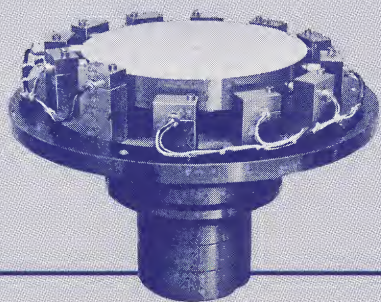
Read Amplifier 8005	Single-Shot 8055
Read Amplifier 8006	Gate Driver 8060
Write Amplifier 8010	Inverter Buffer 8061
Single-Head Select 8020	Flip-Flop 8070
Multi-Head Select 8025	Power Control 1 8081
Diode Gate 8030	Power Control 2 8082
Diode Matrix 44 8040	Power Control 3 8083
Nand Circuit 8050	Read Mode Switch 8090

Cards are mounted in 20-card frames using MIL approved connectors. The frames, which are designed for mounting in standard 19-inch racks, are fabricated with large open areas for unrestricted ventilation of the cards—a feature that increases the life of components.

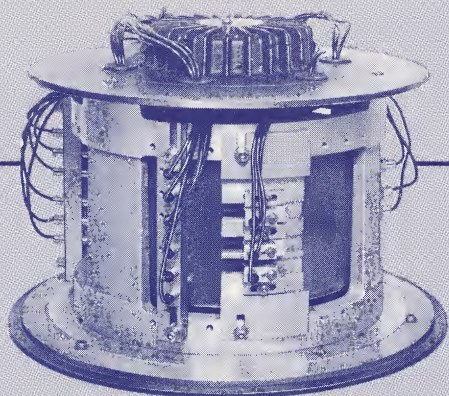


LOW-COST DRUMS

Low-cost drums are available from Bryant to meet the requirements of a wide variety of educational, laboratory, and commercial applications. Backed by more than 30 years of experience in the design and production of precision rotating devices, these low-cost units feature many of the high quality components found in Bryant standard and custom-design drums.



ECONOMY DRUM—The C-675 economy drum stores up to 29,400 bits on 12 tracks. Minimum playback signal is 15 mv. Standard speed is 1800 RPM.

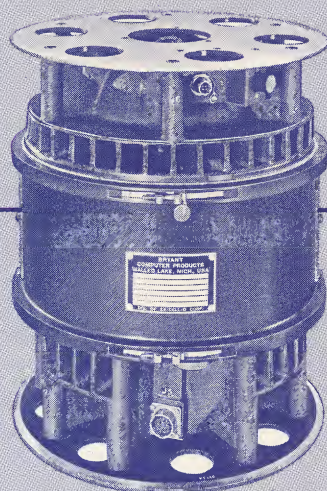


UTILITY DRUM—Bryant's C-105 utility drum offers maximum capacity of 400,000 bits on 100 tracks*. Standard speed is 3600 RPM, with 1800 RPM optional.

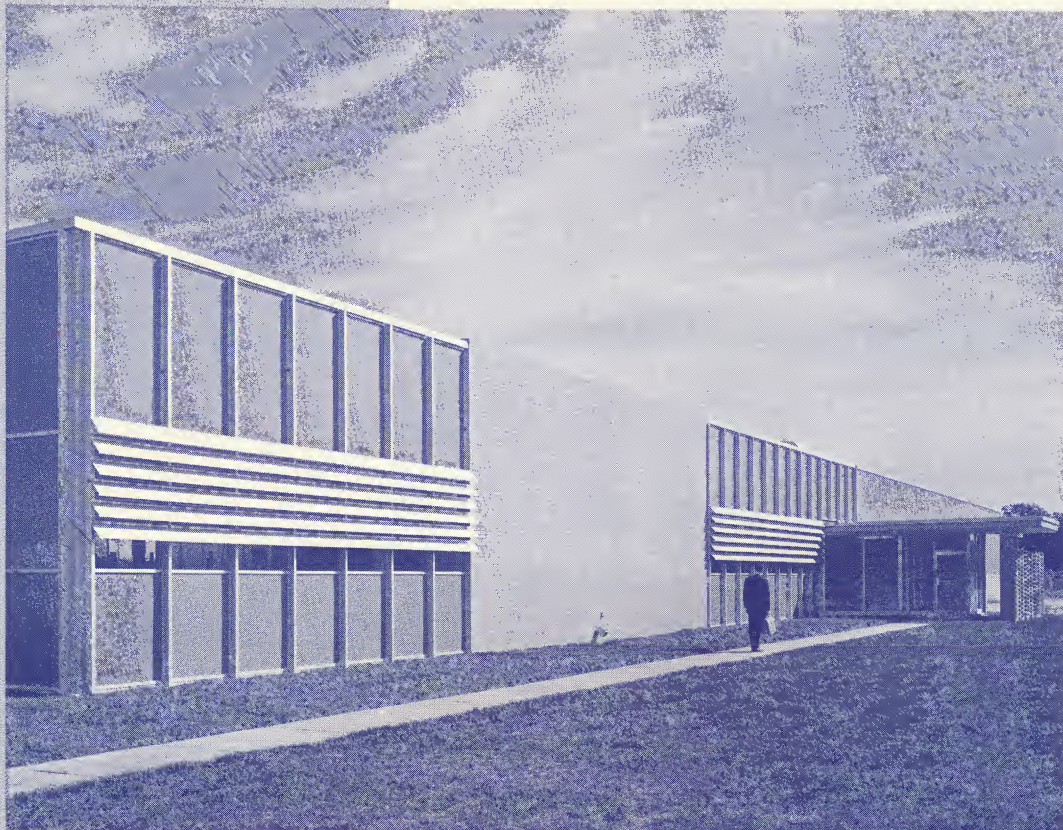
*Clock and register tracks, if required, will subtract from total storage.

CUSTOM-DESIGNED MEMORIES

Custom-designed drums and discs are available from Bryant Computer Products to fulfill the exacting specifications of the most advanced systems. Typical examples include drums ranging from 3" to 20" in diameter . . . air bearing drums with speeds to 120,000 RPM . . . analog recording units . . . low speed units to 2.5 RPM . . . high-speed discs . . . multi-speed units . . . and many others.



AIRBORNE DRUMS—Bryant has developed and produced airborne drums including the A-5003 (left) which meets the environmental and mechanical service requirements of MIL Spec. E-5400B for Class I Equipment. These units are available in capacities of 250,000 bits, with access times as low as 2.7 ms and frequencies in excess of one megacycle.



Bryant Computer Products' headquarters (shown above) are located at Ex-Cell-O Corporation's forty-acre Technical Center in Walled Lake, Michigan—a Detroit suburb. The division's sales and administrative staffs operate out of this facility, and all drum, disc file and electronic systems engineering, assembly and final testing are done here.

Ex-Cell-O Corporation—in publishing this brochure and its associated data—assumes no responsibility for any patent or other rights of a third party and no license is granted by implication, or otherwise, under any patent, patent rights or proprietary rights of Ex-Cell-O Corporation.

BRYANT COMPUTER PRODUCTS

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| ☐ SERIES 4000 DISC FILES | ☐ ECONOMY DRUMS |
| ☐ DISC FILE MEMORY SYSTEMS | ☐ DRUM MEMORY SYSTEMS |
| ☐ AUTO-LIFT DRUMS | ☐ BRYANT CIRCUITS |
| ☐ AIRBORNE DRUMS | ☐ REQUEST SALESMAN CALL |
| ☐ OTHER_____ | |

Name_____

Company_____

Title_____

Address_____

Please send additional information on:

- | | |
|---|--|
| ☐ SERIES 4000 DISC FILES | ☐ ECONOMY DRUMS |
| ☐ DISC FILE MEMORY SYSTEMS | ☐ DRUM MEMORY SYSTEMS |
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Name_____

Company_____

Title_____

Address_____

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data

SERVOMECHANISM CONTROLLED DATA STORAGE DRUM SUBSYSTEMS

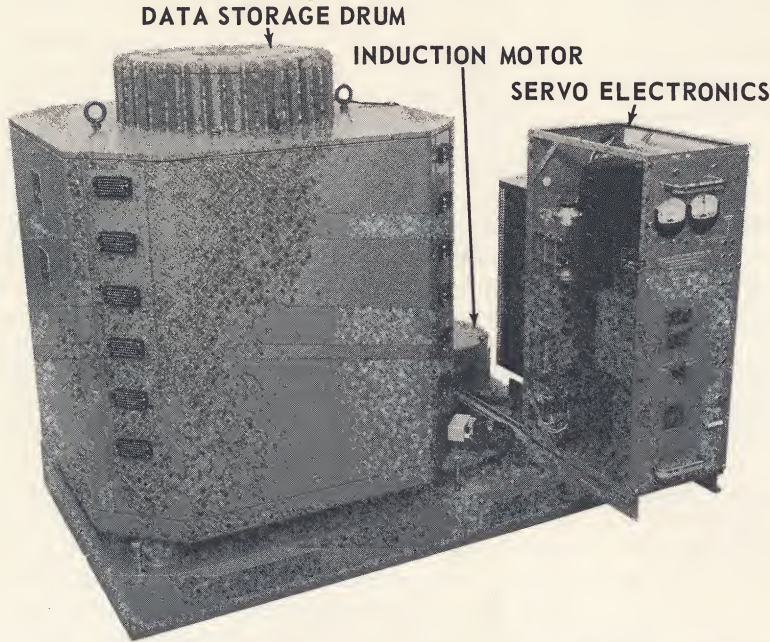


Figure 1 Servomechanism Controlled Bryant Model 185384 Auto-Lift[®] Data Storage Drum Subsystem, Front View — Servo Electronics Extended From Unit to Show Induction Motor

INTRODUCTION

An Auto-Lift Data Storage Drum that can be synchronized to within ± 150 nanoseconds of the speed or speed and position reference of an external, remote data source is now available from Bryant Computer Products!!

The available servomechanism controlled data storage drum subsystem is illustrated in Figure 1. The specific function of this subsystem is to slave the rotational reference of the drum to that of the rotational reference of a radar antenna. Air traffic data detected by the antenna is transferred to and stored on the drum where it is then read off and applied to a CRT for video display. Data stored and subsequently displayed includes conventional plan position indicator (PPI) information as well as transponder generated, alpha-numeric flight identification and altitude information. Synchronization is such that the PPI and alpha-numeric video display of the air traffic is continuously maintained through the data stored on the drum surface regardless of the sweep position of the antenna; coincidental with the sweep position of the

antenna, the data stored on the drum surface is updated to reflect — through the video display — new air traffic information.

The servo-controlled data storage drum subsystem essentially consists of a Bryant Auto-Lift drum that is modified to be belt driven by an induction motor, which is located off to the side of the drum rather than on the upper end of the drum's spindle. The speed and position reference (aximuth of rotation) of the drum is controlled by servo electronics — electrically tied to the remote data source — and a hysteresis clutch/eddy-current brake arrangement included as a part of the drum.

FEATURES

Combined with the time-proven performance of Bryant's Auto-Lift Drum, the servo-controlled data storage drum subsystem offers the following features:

- Position control of the drum can be maintained under

most environmental conditions and power surges.

- The drum of the subsystem can be locked in either speed or speed and position reference with regard to the remote data source.
- Data storage capacity using Bryant's Model 185384 Auto-Lift Drum exceeds 20 megabits; other Auto-Lift drums of larger or smaller capacity can be adapted for use in similar configurations.
- Through the servomechanism control, the data storage capacity of a computer system can be expanded to an almost unlimited number of bits by adding identical drum subsystems — each having common synchronizing clocks — to the basic system configuration.
- The drum subsystem is completely mobile in that casters can be lowered when mobility is required (during operation, the casters are retracted and the assembly sets on shock mounts).
- Servo electronics require no trimming adjustments and construction is ruggedized.
- The servo electronics of the subsystem can accept reference frequencies ranging from 10 Kc to 1 Mc.
- Test points for troubleshooting servo electronics are readily accessible; fault circuits are included wherein non-synchronous drum operation can be remotely indicated.

APPLICATIONS

In addition to the example cited in the introduction, the servo-controlled data storage drum subsystems can be used in many other applications. To mention a few . . .

- The subsystem can be used in delay line and seismographic logging applications where — as in the case of providing a video display — the relationship of the occurrence of the event as sensed by a data source and the playback of the event are extremely important.
- The concept of the subsystem enables an almost unlimited expansion of the data storage capacity of a computer installation by enabling the synchronization of as many subsystems as practical to the computer; thus a combination of drum subsystems — each of equal capacity — would enable, with proper programming, the accessing of multiple data quantities wherein only headswitching time and relative drum displacement — in nanoseconds — would be required to access the data stored in the system.
- The subsystem could be used where position reference of the drum is not of great importance, but where the speed of the drum must be finitely controlled with respect to a remote data source.

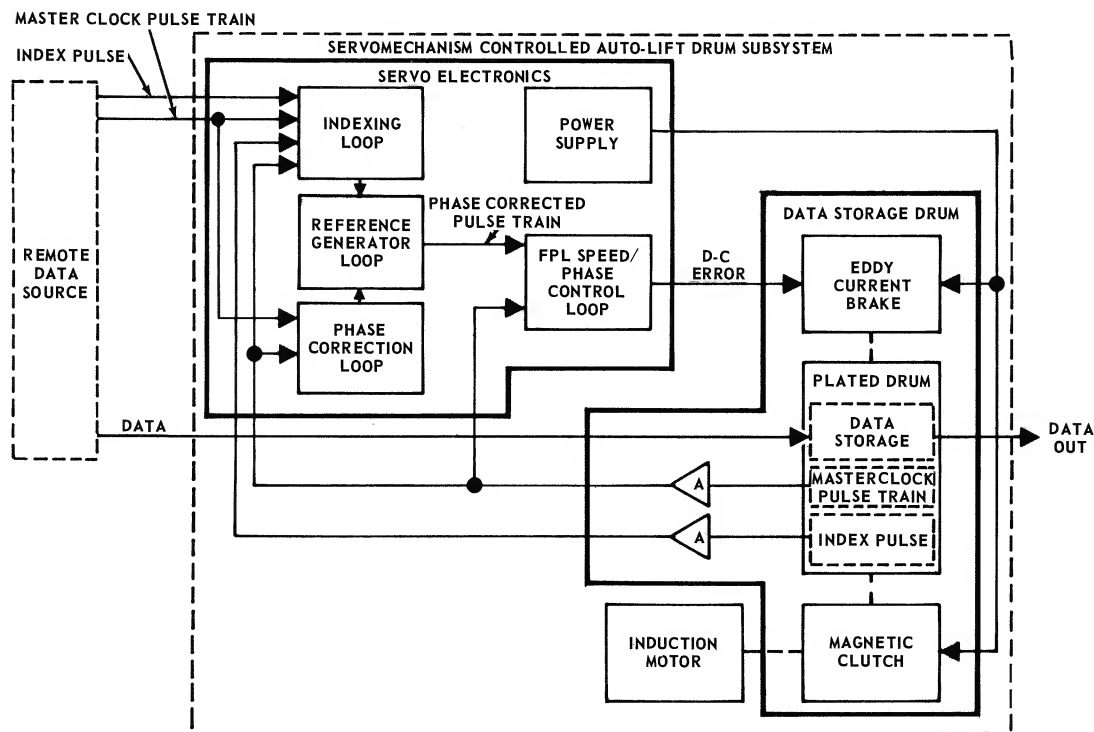


Figure 2 Servomechanism Controlled Auto-Lift Data Storage Drum Subsystem — Simplified Functional Block Diagram

OPERATION

Operation of the servo-controlled data storage drum subsystem is achieved through the interaction of the remote data source and the subsystems data storage drum and servo electronics (see Figure 2).

REMOTE DATA SOURCE CONTROL SIGNALS — A reference index pulse and master clock pulse train are applied from the remote data source to the servo electronics of the drum subsystem. Data from the remote data source is inhibited until the drum is operating in synchronism with the remote data source.

DATA STORAGE DRUM START — An induction motor drives the data storage drum of the subsystem through a belt/magnetic clutch arrangement. An index pulse and a master clock pulse train — read off the drum surface — are applied to the servo electronics of the drum subsystem where they are position compared with the comparable pulses of the remote data source.

SERVO ELECTRONICS OPERATE — The servo electronics is made up of four control loops. These include the phase correction control — or speed reference — loop, the reference generator loop, the FPL speed/phase control loop, and the indexing — or position reference — loop. The drum system can be operated such that the speed and reference position of the drum can be synchronized to that of the remote data source, or so that only the speed of the two are synchronized; in the case of the latter system configuration, the indexing loop is merely excluded from use and all other functions of the subsystem are identical.

Indexing Loop — The indexing loop of the servo electronics continuously monitors the position of the index pulse of the drum with respect to that of the remote data source; the master clock pulse train of both the drum and the remote data source are applied to the indexing loop as reference points for the related index pulses. Deviations in the positioning of one index pulse with respect to that of the other is sensed by gating logic circuits, which select and gate to the reference generator loop the reference signals that will enable correction of the sensed deviation.

Phase Correction Loop — Coincidental to the monitoring function of the indexing loop, the phase correction loop continuously monitors the phase relationship of the pulses of the master clock pulse train of the drum with respect to those of the remote data source. Deviations in the phase relationship of one clock train with respect to that of the other is sensed and converted to a d-c error signal that is proportional to the phase error. This d-c error signal is then applied, with the previously mentioned indexing error signal, to the reference generator loop.

Reference Generator Loop — The reference generator loop senses the error signals from the indexing and phase correction

loops. The sensed error is then used to develop a phase corrected pulse train that serves to null out the error reflected in the inputs of the indexing and phase correction loops. The phase corrected pulse train is applied to the FPL speed/phase control loop.

FPL Speed/Phase Control Loop — The phase corrected pulse train of the reference generator loop is frequency/phase compared with the clock pulse train from the drum in the FPL speed/phase control loop. The resulting phase displacement is converted to a d-c error signal that is proportional to the detected phase error. This d-c error signal is amplified and applied to the data storage drum.

DATA STORAGE DRUM OPERATE — Drum speed is controlled through an eddy current brake; that is, the amplified d-c error signal from the FPL speed/phase control loop of the servo electronics to the eddy current brake provides a torque change to the drum that ultimately synchronizes the drum speed or drum speed and position reference to within ± 150 nanoseconds of those of the remote data source. With drum speed and/or position reference synchronized to that of the remote data source, data transfer from the source to the drum surface and from the drum surface to where it is to be used is enabled.

SPECIFICATIONS

SYSTEM CHARACTERISTICS

Over-all Dimensions

See Figure 3

Weight

1000 pounds

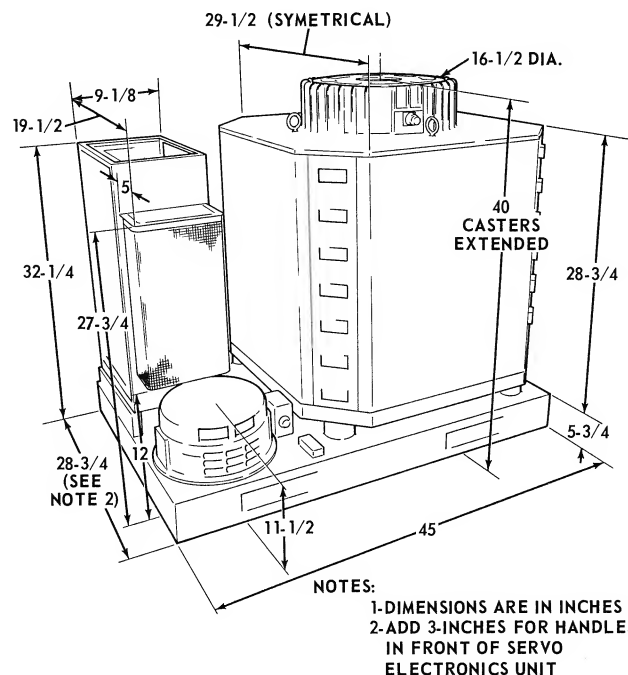


Figure 3 Servomechanism Controlled Auto-Lift Data Storage Drum Subsystem Using Model 185384 Drum, Rear View — Installation Dimensions

DRUM CHARACTERISTICS*

Enclosure Dimensions

Height	35 inches
Width	30 inches

Number of Data Tracks	400
-----------------------	-----

Track Width	0.020 inch
-------------	------------

Capacity	20 megabits
----------	-------------

DRUM MOTOR CHARACTERISTICS (Cont.)

Power Requirement	208-volt $\pm$ 10%, three phase, 60 cps $\pm$ 5%
-------------------	---

Current	
Start	10 amperes
Run	6.5 amperes

Speed	1800 rpm
-------	----------

DRIVE MOTOR CHARACTERISTICS

Type	Induction, belt drive
------	-----------------------

SERVO ELECTRONICS CHARACTERISTICS

Power Requirement	Common to that of the drive motor
-------------------	-----------------------------------

Reference Frequency	10 Kc to 1 Mc
---------------------	---------------

* Characteristics listed apply specifically to Bryant's 185384 Auto-Lift Drum; for additional details relating to this drum and other drums of the Auto-Lift line, request Bryant's Auto-Lift Drum Brochure.

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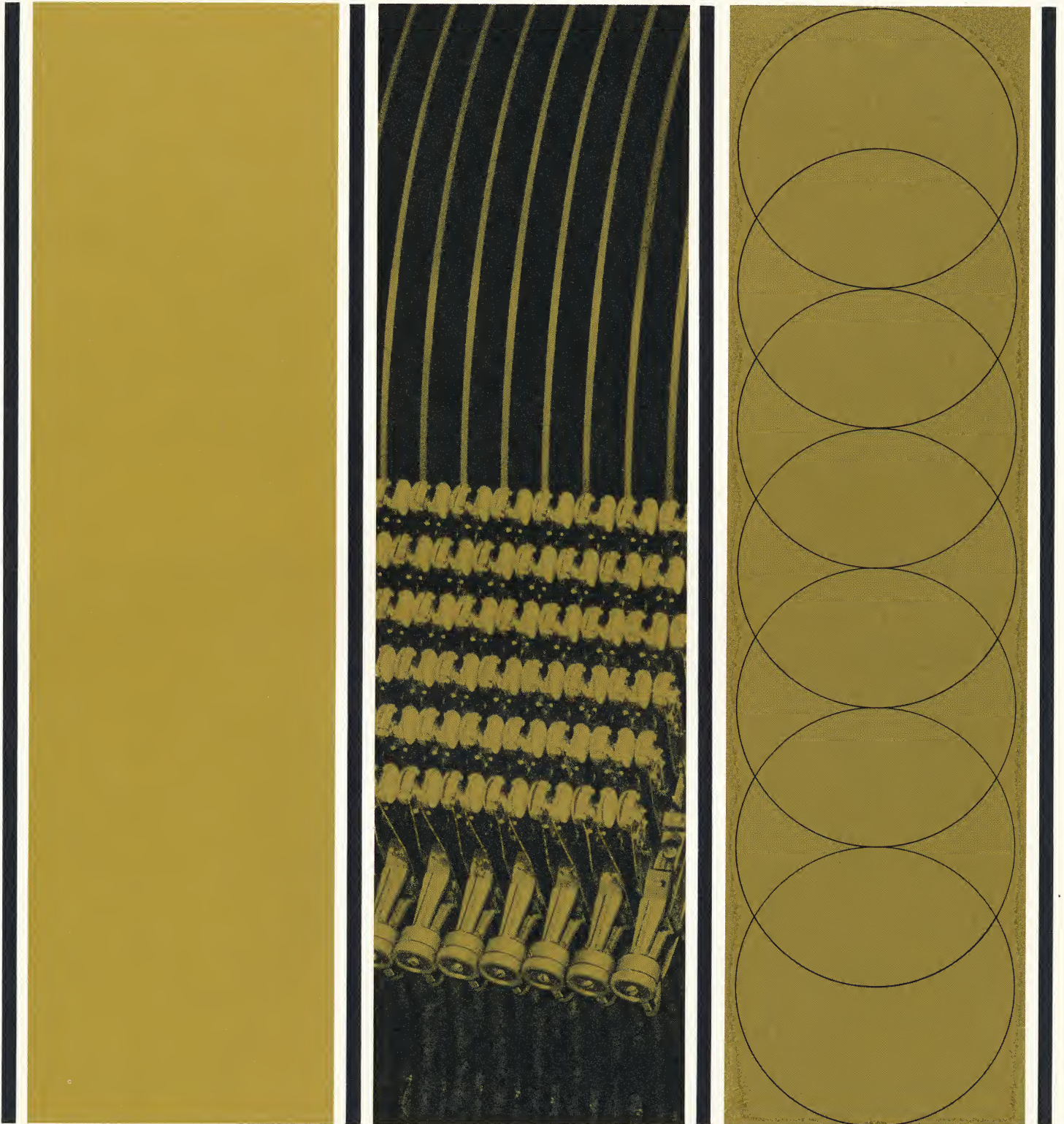
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LARGEST UNIT CAPACITY—LOWEST COST PER BIT

The Bryant Model 2A Series 4000



Bryant Model 2A Series 4000 Disc File Systems

The Bryant Model 2A Series 4000 Disc File Systems comprise a new generation of mass memories that combines large capacity of 3.8 billion bits within a single unit, with extremely high performance capabilities that are required by today's advanced information processing systems. It provides computer users speed and productivity many times greater than conventional disc file systems, and is by far the lowest costing random access system available on the market today.

This new Model 2A Disc File System offers distinct advantages in the areas of price, capacity, access speeds, reliability, and maintainability—areas that are measures of disc file system capabilities. Among the many outstanding features included in this disc file system are:

LARGE CAPACITY: Up to 3.8 billion bit capacity; allowing extensive management information systems to be developed with all the data on-line and immediately available, at an average positioning time of 110 milliseconds.

ECONOMICAL EXPANSION: Storage is available in increments of up to 151,000,000 bits, that is field installed on an individual disc basis. Thus the system can be easily tailored to user's expansion requirements.

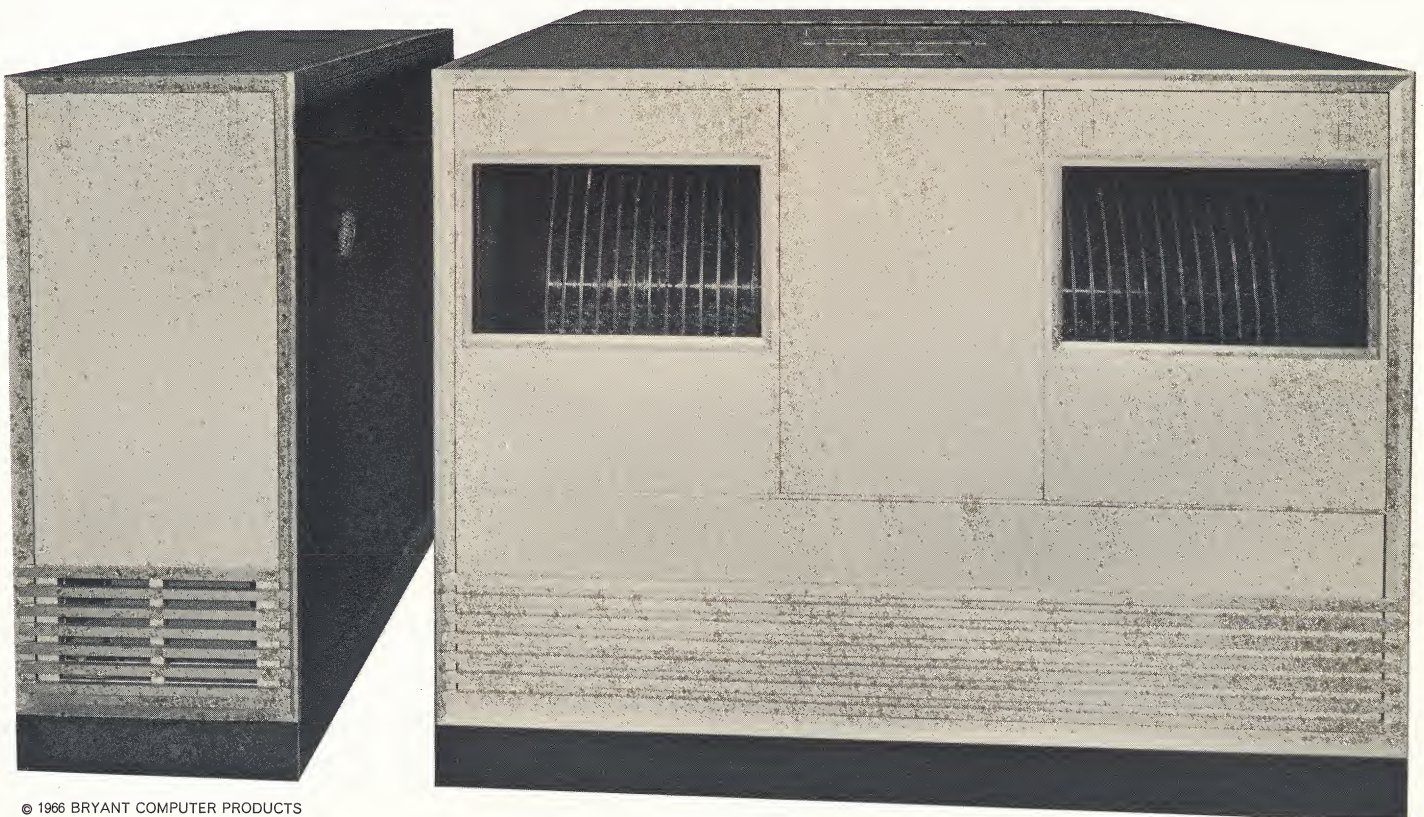
DUAL ACCESS SYSTEM: A dual access head positioning system is available as an optional feature that will permit independent operation of each side of the file, increasing programming flexibility.

MODULAR DESIGN: The Model 2A Disc File System includes two basic machine sizes, each modularly designed to accommodate from one to its maximum complement of discs.

ENVIRONMENTAL CONTROL: Assures on-line availability and reliability and minimum maintenance, through self-contained cooling and 100% air filtration of file interior.

STANDARD BRYANT INTERFACE: All Model 2A's are equipped with the reliable time proven Bryant electronic circuit modules to perform the clocking, head switching, write/read and logic functions required for operation of the disc file.

HIGH DENSITY RECORDING: The Model 2A Disc File achieves rated capacity through bit densities and transfer rates conservatively rated well within the state of the art. Maximum bit density in Model 2A files is 800 b.p.i.

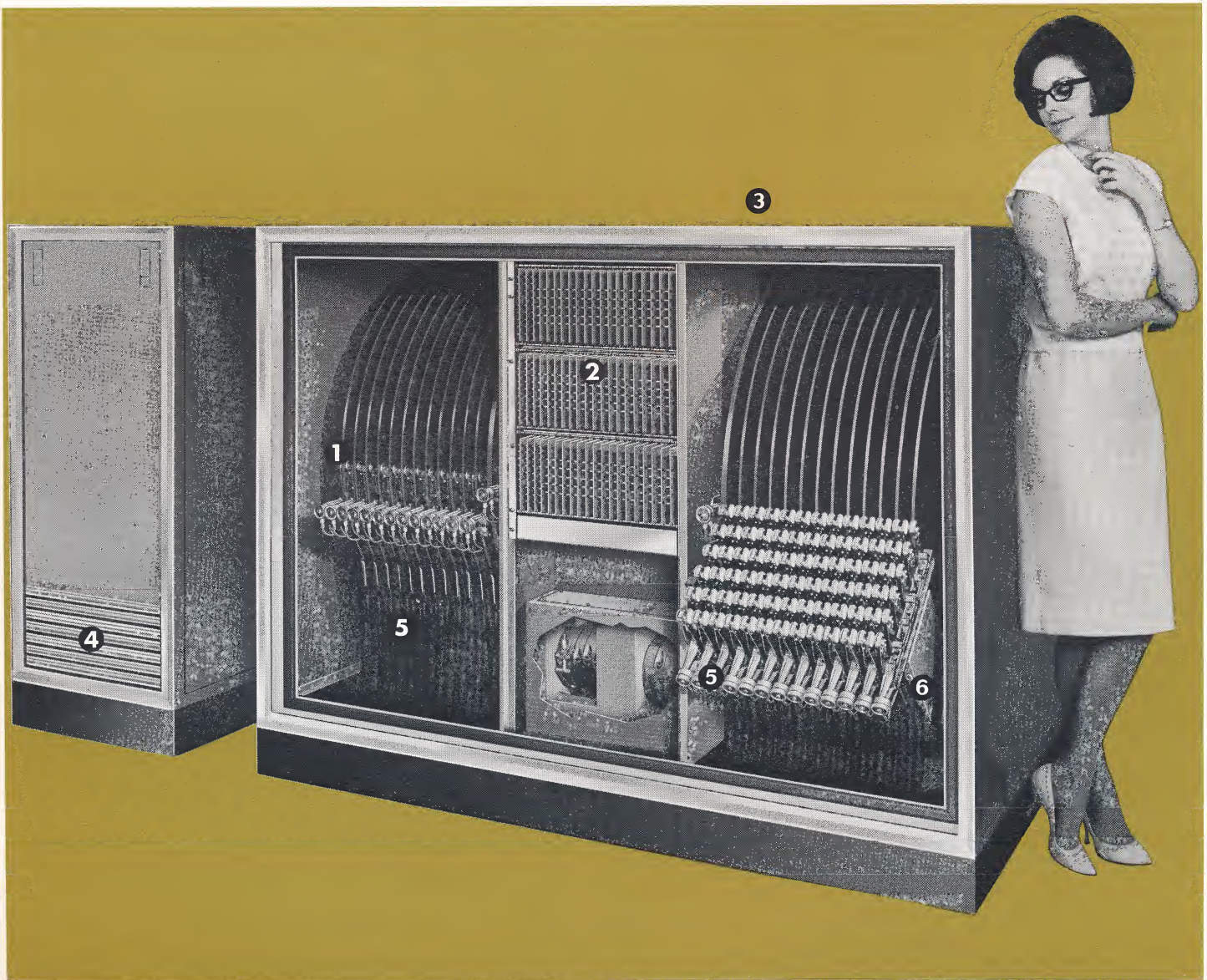


Model 2A Series 4000 Disc File

① **High Density Recording**—All MODEL 2A Series 4000 Files are capable of writing and reading back data reliably at packing densities up to a 800 bits/inch when recording in phase-modulation mode. This means you can store 75.5 million bits per data surface—or up to 3.8 billion bits in the 26-disc mass memory.

② **Electronic Interface**—Write, read, head select, and logic electronic circuit modules are mounted in hinged racks conveniently located in separate air-cooled bay accessible through center panel. Systems can be designed to meet your specific requirements with respect to data rates, control signals, capacity, and mode of operation.

③ **Environmental Controls**—All MODEL 2A disc files are equipped with an environmental control unit designed especially to minimize air contamination and maintain the proper environment for optimum file performance. Attached to rear of file, each unit provides full-flow mechanical filtration and self-contained mechanical cooling.



④ **Power Controls**—Furnished in a separate cabinet as shown, this compact power control unit features point-to-point connections for all electrical and hydraulic elements in accordance with recommendations of Underwriters' Laboratories, Inc.

⑤ **Dual/Rapid Positioning**—New Rapid random-access system consists of an independent, open-loop, electrohydraulic digital head positioner for each side of the file—with each positioner controlled by separate signals. This permits use of each module as an individual memory, provides greater versatility and faster access.

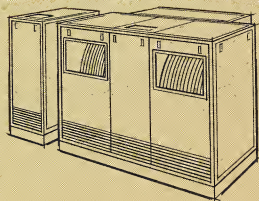
⑥ **Signal Preamplifier**—Magnetic heads terminate in a preamplifier/switching device mounted near the related head bar. Each services 12 heads and provides signal gain for the read amplifiers. This arrangement reduces cabling impedance, improves resonance frequency, minimizes noise.

The System . . .

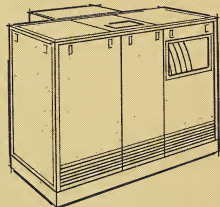
CONFIGURATIONS . . .

The new generation of Model 2A Disc File System is provided in two basic configurations: A Model A-2A Disc File and a Model C-2A Disc File. The Model A-2A Disc File is designed to accommodate from one to 13 discs, including a clock disc, and is available with disc speeds of either 900 RPM or 1200 RPM, with single head positioner. Each head is positioned to 256 data tracks. This model offers a maximum capacity of 1.8 billion bits (225 million 8-bit characters).

The Model C-2A system contains a maximum of 26 discs, including clock discs, and is available with disc speeds of 900 RPM or 1200 RPM, with either single or dual head positioners. Each head is positioned to 256 data tracks. This model offers a maximum capacity of 3.8 billion bits (475 million 8-bit characters).



MODEL C-2A SERIES 4000 Two module file containing maximum of 26 discs or 52 disc surfaces—50 for general data storage; one for prerecorded clocks and fast access data; and one for prerecorded track verification data and for general data storage, sector relocation. Available with speeds of 900 or 1200 rpm—single or dual access.



MODEL A-2A SERIES 4000 Single module file containing maximum of 13 discs or 26 disc surfaces—24 for general data storage; one for prerecorded clocks and fast access data; and one for prerecorded track verification data and for general data storage, sector relocation. Available with speeds of 900 or 1200 rpm—single access.

DUAL ACCESS POSITIONING SYSTEM

With the dual access positioning system option of the Model C-2A, each module or side of the file can be operated independently. Thus there are no restrictions on using the two file modules of the disc file. One head positioning system can be used to select tracks in a random mode while the other is selecting tracks sequentially. One module of the file can therefore be used with one computer while the other works simultaneously with another computer. In addition, both modules of the file can be programmed for use with the same computer by alternately reading or writing on one side and then reading or writing on the other side.

ADVANTAGES OF DUAL POSITIONING

The optional dual access positioner system of the Model C-2A Disc File is the same as the single positioner system, however, the dual access positioner system can be operated and controlled as an independent system, or programmed to operate in a simultaneous mode.

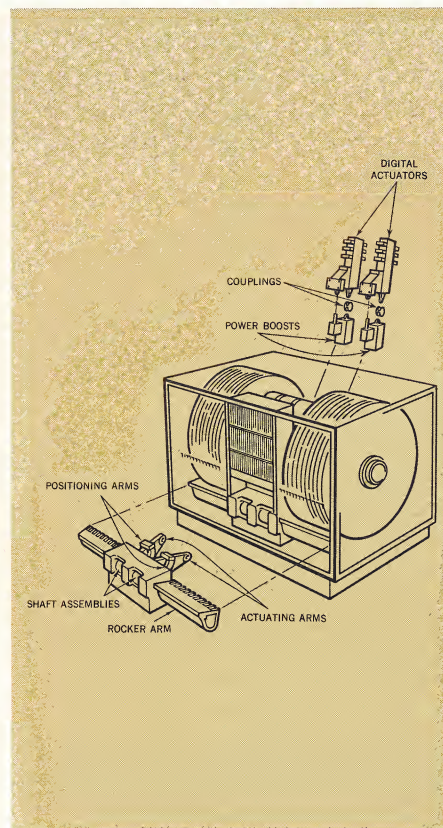
The Model 2A Disc File System offers as standard, a single access positioner, which is an open loop electrohydraulic digital actuator that contains a built-in power amplification, as well as acceleration and deceleration control.

An eight-bit binary static address controls 256 discrete locations on the single positioner system.

The single access positioner system provides users maximum storage capacity with a minimum of hardware, economically.

A typical application whereby a single data channel is programmed to serve both access positioners simultaneously, provides the advantages of reducing overall system access time by time sharing positioning time to the data store; provides for low cost, rapid access and multiple programming capability; also two access mechanisms assures minimum load and unload cycles, releasing the computer for more time, thus profitable purposes.

Still another example is the application whereby the system is programmed for use with two access positioners with two data channels, offering the advantages of dual, simultaneous read/write access to the data store, providing high throughput, reducing queues or eliminating them altogether with two-console operation. Also, the loss of one channel provides graceful degradation or reduced system throughput instead of total loss.



Model 2A Disc File Organization

Data organization in the 1536 data tracks on each disc surface of the Model 2A Disc File is completely unrestricted. The tracks may or may not be divided into equal record lengths at the customer's option. Discrete-bit clocks, character clocks, word markers, and address data are prerecorded to meet user's requirements. To accommodate the clock tracks, each Model 2A Disc File System incorporates an additional clock disc. One surface of this clock disc is accessed by fixed-position clock heads. The other surface is accessed by six positionable data heads in the same manner as the data discs and they may be used for that purpose. If additional clocks or fast access tracks are required, another clock disc can be supplied in place of a data disc on the Model C-2A Disc File System.

In order to maximize capacity while at the same time limiting the variety of recording frequencies, the 1536 concentric data tracks on each disc surface are grouped in zones with all tracks in a zone having the same record length and frequency. Six zones, one for each Write/Read head may be used in the Model 2A Disc File System.

The track lengths of the six zones can be related in that they may be all multiples of the basic record or word length.

The track lengths of the zones are also arranged to achieve long storage blocks by adding tracks of two or more zones together in tandem. Only one requirement must be observed when programming the discs to meet system requirements—

the maximum bit densities in each zone should not be exceeded.

DATA FORMAT

All data in the Model 2A Disc File System is stored in a self-clocked block format. The number of blocks in each track are dependent upon the application. The Data Track format of the Model 2A Disc File system is as follows:

HEADER PREAMBLE

The Header Preamble is used to synchronize the self-clocking data demodulating circuitry and is 10 bits in length. The Header Preamble must contain at least 9 zeros followed by a 1.

HEADER DATA

The Header Data contains the sector identification information and precedes the sector it identifies. The Header Data length is variable.

HEADER POSTAMBLE

The Header Postamble consists of two valid bits that are written in-phase with the preceding data and are used for clocking of data within the disc file system.

DATA PREAMBLE

The Data Preamble is used to synchronize the self-clocking data demodulating circuitry and is 10 bits in length. The Data Preamble must contain at least 9 zeros followed by a 1.

DATA

The useful data recorded on the file, variable in length depending on the requirement.

CHECK BITS

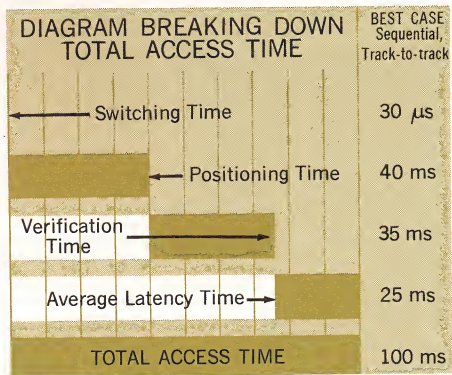
The Check Bits are used as error detection and/or correction data, and are written in-phase with preceding data bits.

DATA POSTAMBLE

The Data Postamble consists of two valid bits that are written in-phase with the preceding data, to provide clocking within the disc file system.

ACCESS TIME AND COMPONENTS

There are several factors affecting the access times to data in a random access, mass storage device. The significance of each factor depends on the particular application. The application must be analyzed to obtain an accurate estimate of the time required to perform any single operation or series of operations.



SWITCHING TIME

Switching time within the Model 2A Disc File System involves the time required to electronically switch from one read head circuit to another read head circuit while in the read mode operation. This time averages 30 microseconds. Write to read switching time averages 50 microseconds.

POSITIONING TIME

The positioning time in the Model 2A Disc File System is defined as the time required from the moment a specific data track is selected until the selected track is reached and the signal amplitude is at its full value continuously. The average positioning time is based on the following:

Average moves =

$$\frac{\text{Sum of all times of possible moves}}{\text{Number of possible moves}}$$

HEADER PREAMBLE	HEADER DATA	HEADER POSTAMBLE	DATA PREAMBLE	DATA	CHECK BITS	DATA POSTAMBLE
-----------------	-------------	------------------	---------------	------	------------	----------------

However, positioning time is also dependent upon the data track address desired and the size of the file utilized, as shown in the following tables:

SINGLE ACCESS POSITIONER SYSTEM		
Time	1 to 13 Discs	14 to 26 Discs
Minimum	40 ms	40 ms
Average	100 ms	110 ms
Maximum	160 ms	180 ms
DUAL ACCESS POSITIONER SYSTEM (C-2A DISC FILES ONLY)		
Time	Modules of 1 to 8 Discs	Modules of 9 to 13 Discs
Minimum	40 ms	40 ms
Average	100 ms	110 ms
Maximum	160 ms	180 ms

VERIFICATION TIME

The verification time is the time required to ensure that the positioning system has moved the heads to the addressed track and that the heads have stabilized for a read/write operation. This time is generally 15 ms.

LATENCY TIME

Latency time is the time required, after the positioner has settled, to locate the addressed record on the Model 2A Disc File System. Latency is a function of record length and the rotational speed of the disc file and will average 25 milliseconds when rotating at 1200 RPM and 34 milliseconds when rotating at 900 RPM.

SYSTEM CAPACITY

The storage capacity of the Model 2A Disc File System depends not only upon the individual characteristics of the magnetic surface and the write/read heads, but also upon the recording mode of operation chosen for the disc file system and the signal retrieval characteristics of the playback circuit. Phase modulation recording with a self-clocked peak detection technique is used for recording on the Model 2A Disc File System with either serial or parallel operation.

The storage capability of the Model 2A Disc File System is best visualized in accordance with the drum mode operation. If the file is equipped with the optional dual access positioning system, the moving heads for each module or side of the file are connected to separate actuating mechanisms. If the file is equipped with a single access positioning system the heads are connected to the same actuating/positioning mechanism. Thus, when the file seeks out information, all of the heads attached to the same actuating system move together—each of the heads servicing a data disc surface is positioned over the same relative track as its counterpart servicing another disc surface. Thus for each of the six groups of 256 tracks on the file, there are as many as fifty write/read heads over the same track position at any one time. This is similar to having six 50-head drums—the track length within each "drum" being the same but different from drum-to-drum.

THE STORAGE DISC

Bryant Computer Products magnetic oxide material is applied to both sides of 39-inch solid magnesium discs to form the recording media of the Model 2A Disc File System. The Model C-2A Disc File System contains 25 data

discs and utilizes 50 data surfaces. The Model A-2A Disc File System contains 12 data discs, utilizing 24 data surfaces. Each storage surface accommodates 1536 data tracks, which are divided into 6 addressable zones. The total storage capacity of each disc is 151,183,360 bits (18,897,920 8-bit characters).

DATA TRANSFER RATES

The Bryant Model 2A Disc File System offers a character transfer rate of a minimum of 344 KC at 900 RPM and maximum of 1094 KC. When operating at 1200 RPM the character transfer rate provides a minimum of 458 KC and a maximum of 1459 KC. The maximum recording density is 800 bits per inch.

HEAD POSITIONING SYSTEM

A differential movement of a rocker arm is used to selectively position the magnetic heads, and is achieved by a unique open loop, mechanical/hydraulic actuator. The actuator produces linear movements to swing all of the heads simultaneously to any one of 256 desired positions. The positioning system consists of a digital actuator and power boost. The actuator, being binary, requires eight separate input signals.

Dual access positioning is possible as an optional feature with the Model 2A Disc File System, and permits the one unit to act as two separate independent modules.

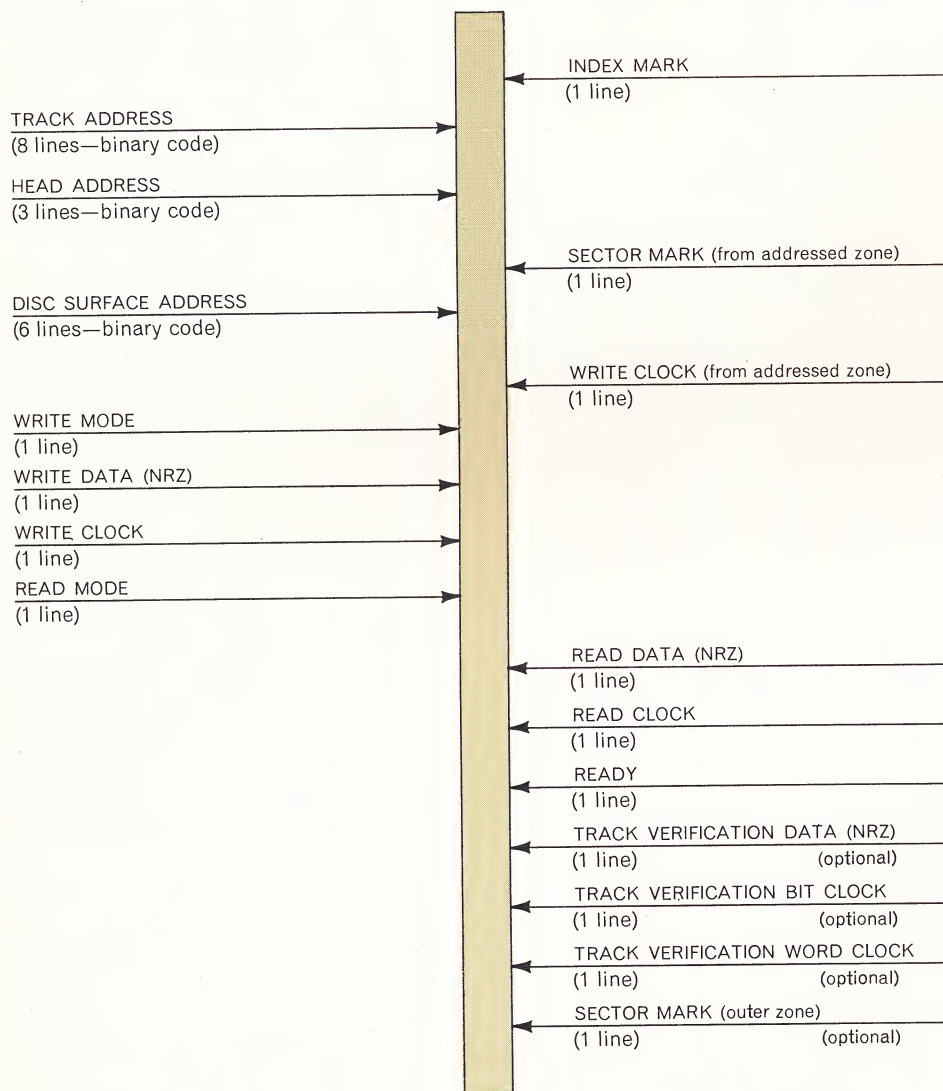
READ/WRITE HEADS

One magnetic head is used to perform both the read and write operations. Six read/write heads are used to service each disc surface with a total quantity of read/write heads dependent on the size disc file in use. Each read/write head is movable to serve 256 desired locations on the disc surface.

System Interface

INPUT/OUTPUT INTERFACE LINES

The Model 2A Disc File System interface is shown below:



INDEX MARK—

An index clock output used to represent the start of each disc revolution.

TRACK ADDRESS—

An 8 bit binary coded input used for addressing the digital positioner to one of 256 discrete positions.

HEAD ADDRESS—

3 binary coded input lines are used to select one of six head zones of the disc surface.

SECTOR MARK—

The sector mark is a single bit; the number of bits on the track will correspond to the number of blocks per-revolution.

DISC SURFACE ADDRESS—

Six binary coded inputs that are used to select the proper disc surface.

WRITE CLOCK—

(to control unit)

The write clock is operated at the frequency of the selected zone, and during a write operation, the write clock must be counted by a control unit in order to store the correct number of bits in a block.

WRITE MODE—

The write mode controls the writing operations on the disc and is synchronized with the appropriate sector clock and write clock and begins and ends at the same relative position in the block.

WRITE DATA—

Provided for write data input into the disc file and shifts data when the write clock changes from the logical "1" level to the logical "0" level. The data formatting control must be performed by an interface control unit.

WRITE CLOCK—

(to disc file)

Provides for write operations within the disc file and acts as the write clock output return to avoid propagation delay problems.

Environment

READ MODE—

The read mode causes the transfer of data from the disc file system, and is sufficiently delayed so that it begins at least 2 bits after the start of the preamble, and 8-bits before the start of the data. The read mode terminates after the last bit is read.

The data and clock output are both inhibited until the preamble is read in order to allow the first bit from the disc file to be data. During a read operation, the clock bits must be counted by the control unit in order to control the termination of the read enable. When reading sequential blocks, the read enable begins and terminates during each block.

READ DATA—

Reads data out from the disc file, and is active only during a read operation.

READ CLOCK—

The read clock is active only during a read operation, and the first read clock occurs coincident with the first bit of data.

READY—

The ready signal is used to indicate the disc file system is up to correct speed and ready for operation.

TRACK VERIFICATION— (optional)

Track verification data is stored independently on one disc surface and read continuously.

TRACK VERIFICATION—

BIT CLOCK (optional)

This clock is used in detecting the track verification data.

TRACK VERIFICATION—

WORD CLOCK (optional)

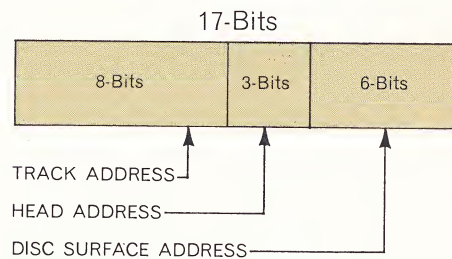
This clock is provided at the eighth-bit time of each word for synchronizing purposes.

SECTOR MARK— (optional)

This sector mark is used for counting the sectors of track verification in the outer zones of the disc surface.

ADDRESS FIELDS

The following Address are transmitted to the Model 2A Disc File System via the system input interface lines as previously shown.



DUAL ACCESS

All input/output interface lines are duplicated for completely independent dual-access operation. Some system options would not require complete duplication.

ENVIRONMENTAL CONTROL UNIT

Model 2A Disc File Systems are equipped with an Environmental Control Unit which maintains optimum internal temperature and air filtration. The Environmental Control Unit allows infrequent maintenance periods.

OPERATING CONDITIONS

The Model 2A Disc File System operates within any plus or minus 10°F range, between 60°F and 90°F.

Specifications

Standard Systems

CAPACITY

3.8 billion bit over-all; 151,000,000 bits per disc.

POSITIONING TIME

	Single	Dual
Maximum	180 ms	180 ms
Minimum	40 ms	40 ms

RECORDING

Mode-Phase modulation

Density

Zones 1 and 2—600 bpi (max.)

Zones 3 to 6—800 bpi (max.)

DISCS

Number of total discs—13, Model A-2A;
26, Model C-2A

Tracks per disc surface—1536

Speeds—900 or 1200 RPM

Diameter 39 inches

Coating—Magnetic oxide

PHYSICAL

Disc File

Model A-2A System

Height—52 inches

Depth—46 inches

Width—70 inches

Weight—3440 lbs.

Model C-2A System

Height—52 inches

Depth—46 inches

Width—70 inches

Weight—3340 lbs.

Environmental Control Unit

(2 Ton Model A-2A only)

Height—52 inches

Depth—33 inches

Width—34 inches

Weight—600 lbs.

Environmental Control Unit

(3 Ton Model C-2A only)

Height—52 inches

Depth—35 inches

Width—70 inches

Weight—1000 lbs.

PHYSICAL (Cont.)

Power Control Unit (Model C-2A only)

Auxiliary Cabinet

Height—52 inches

Depth—46 inches

Width—22 inches

Weight—910 lbs.

(The power control unit contains the hydraulic and electrical controls required for operation of the disc file—these controls are self-contained in the Model A-2A Disc File)

Electronics Auxiliary Unit (Optional)

Height—52 inches

Depth—46 inches

Width—12 inches

Weight—175 lbs.

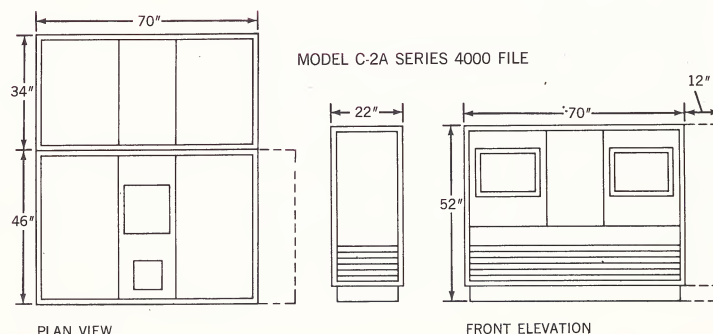
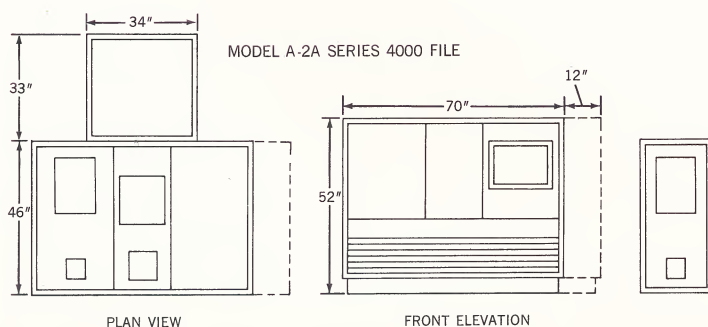
ELECTRICAL

Voltage

208 VAC or 440 VAC $\pm$ 10% 3-phase,
50/60 cycles

Power

13 Discs	208 (60 cycles)	440 (60 cycles)
1200 RPM	48 Amps.	27 Amps.
900 RPM	38 Amps.	19 Amps.
26 Discs	208 (60 cycles)	440 (60 cycles)
1200 RPM	—	32 Amps.
900 RPM	42 Amps.	—



PARTIAL LIST OF BRYANT SERIES 4000 DISC FILE USERS

(Over 190 in operation since 1963 in United States, Japan, England, Germany, Finland, Switzerland, Australia, France.)

RCA—Inventory Control • Data Processing • On-Line Order Processing

Collins Radio—Message Switching • Reservation Systems

Control Data Corporation—Scientific Data Processing • Reservation Systems

ICT—On-Line Inventory Control

Siemens and Halske—Reservation Systems

ITT—Message Switching

Hitachi—Business Application

Philco—Business Application

CIT—Business Application

and others . . . including field intelligence data collection systems for the Signal Corp.

BRYANT
COMPUTER PRODUCTS

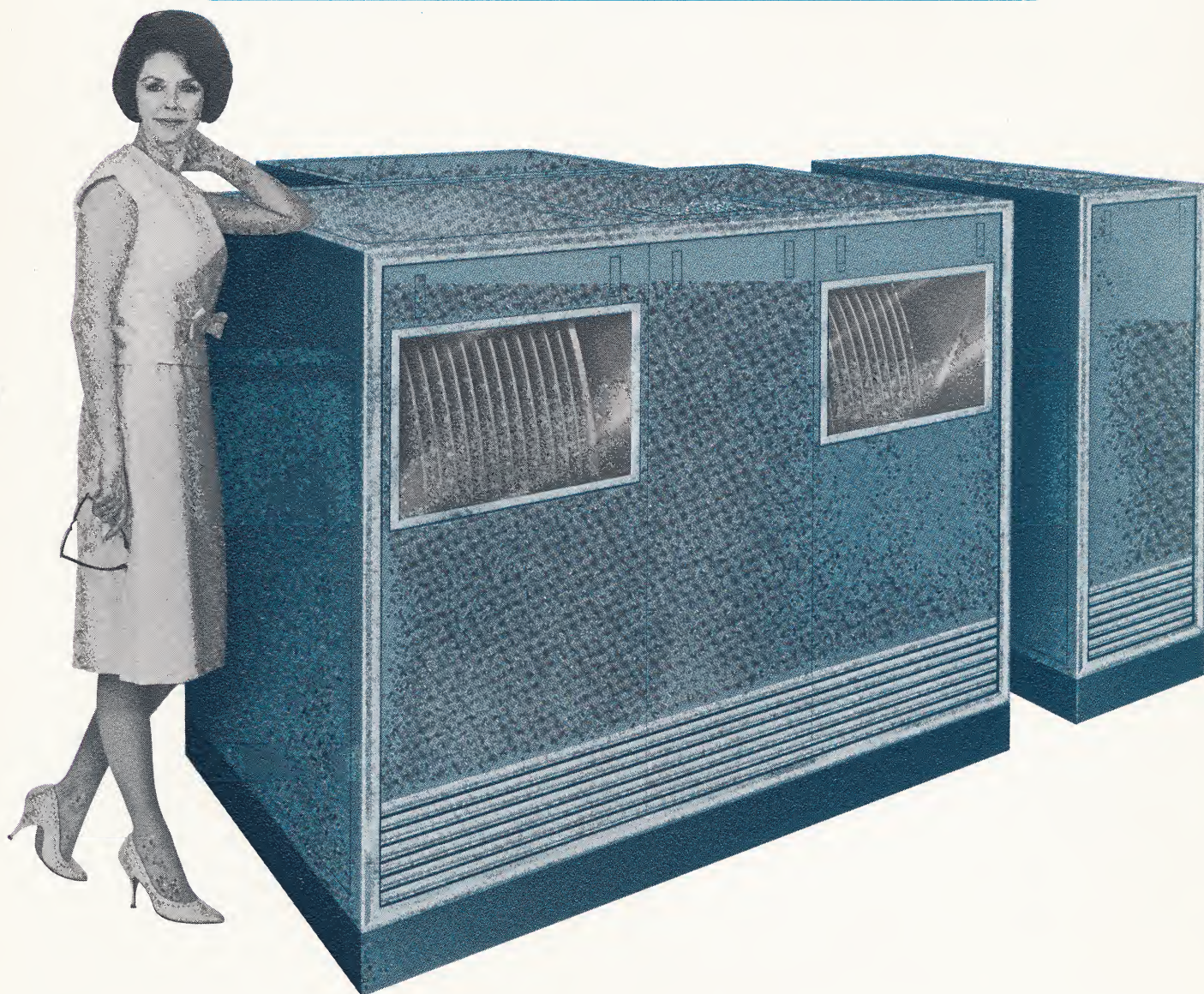


EX-CELL-O CORPORATION

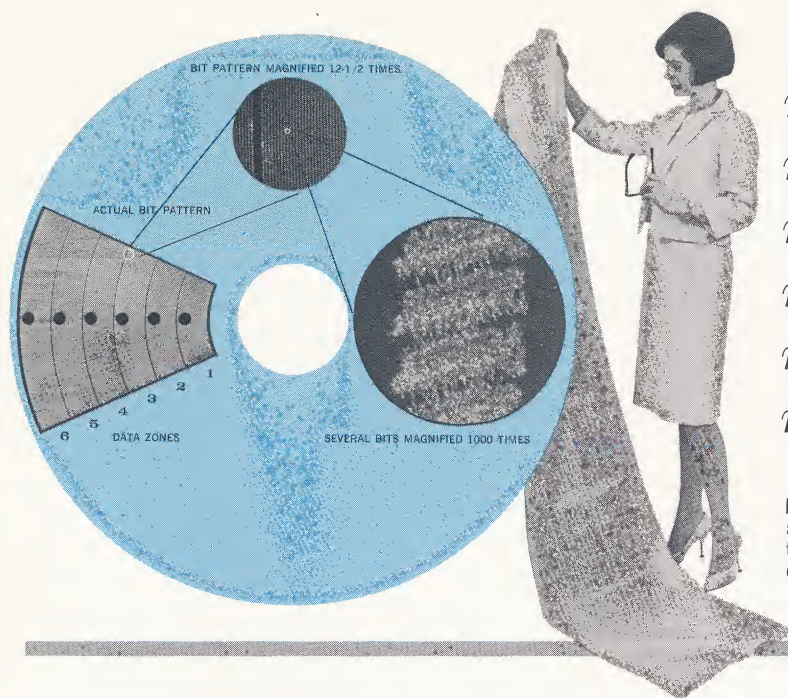
850 LADD ROAD, WALLED LAKE, MICHIGAN 48088
TELEPHONE 313/624-4571 TWX 810/231-7190

BCPB 112-4-66 LITHO IN U.S.A.
(1-1-67R)

*more of everything
you need and want
in a random-access
mass memory...*



BRYANT **Model-2** **DISC FILES**
SERIES 4000



new programming flexibility!
new Dual/Rapid random access!
new environmental independence!
new on-line maintainability!
new long-term reliability!
new lower cost per bit!

□ Multiple magnification of disc surface at left above shows several bit patterns enlarged 1000 times. With the new MODEL 2 Series 4000C file, cost per bit can be as low as 0.0075 cent!

BRYANT Model-2 DISC FILES

SERIES 4000

You might think, at first glance, that new MODEL 2 Series 4000 disc files are pretty much like their predecessor — the original Bryant Series 4000 random-access mass memories that have served so well so long in over 150 key computer and data processing installations throughout the world. And in a great many respects they are.

Same modular design concept. Same rugged precision mechanical construction. Same basic proven operating principles. Same wide range of capacities — with series and parallel clocked or self-clocked recording, unrestricted record length, and fail-safe data protection in the event of external power failure.

But there's a lot that's new in the MODEL 2 — many important advancements designed to reduce maintenance, improve reliability and increase programming flexibility. For example:

All Bryant MODEL 2's are equipped with a new self-contained environmental control that maintains the disc file modules at a fixed proper operating temperature, cleans circulating air, and assures positive internal pressurization.

This means shorter warm-up time — usually less than 15 minutes, or almost immediately for reading if self-clocking is used. It also permits convenient on-line maintainability — with total down-time for scheduled maintenance reduced to approximately 42 hours per year, or less than 1% of normal operating time.

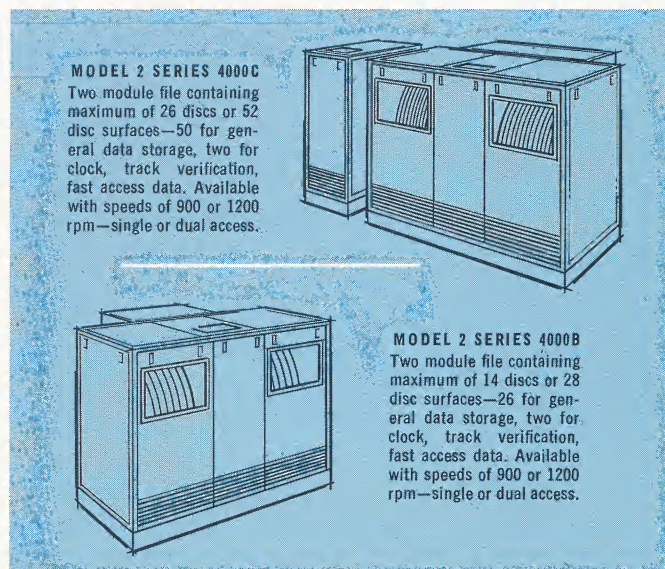
Reliability has also been improved — not only through control of environmental factors — but at the component level as well. Two major sub-systems have been simplified, and several precision operating mechanisms have been redesigned for greater accuracy and longer life. As a result, mean-time-between-failures for new MODEL 2 disc files has been determined to be from 2,000 to 3,000 hours — depending upon application conditions, file configuration, and the quality of customer maintenance.

Note, too, that the electronic interface has been consolidated in a completely isolated air-cooled compartment conveniently located up front behind the center panel. All optional read, write,

and head select electronic circuit modules are packaged together in a hinged card rack for quick, easy accessibility and as close to the magnetic heads as possible. Also, a new preamplifier switching device has been mounted near each head bar to minimize cabling and obtain improved playback signals.

Where the original Series 4000 files were available with single access head positioning only, the new Model 2's can be furnished with a Dual/Rapid random access head positioning system that permits independent operation of the two sides or disc file modules and greatly increases programming flexibility.

Last, but by no means least, is the fact that all of these new value features and major improvements have been accomplished in a manner that has actually reduced your cost per bit — down to as low as 0.0075 cent, or only 0.06 cent per 8-bit character!



File Organization—"Drum Mode" Concept and Dual/Rapid Random Access Provide Maximum Programming Flexibility

Bryant MODEL 2 Series 4000 Disc Files are designed to operate with any medium or large computer as a massive external store supplementing an internal memory—or to function with on-line data communications systems. As such, it permits high data transfer rates and greatly increases "thruput" for applications requiring frequent reference to large volumes of data. Moreover, it offers a computer or edp programmer almost unlimited opportunity to layout a data storage format of any type.

FILE ORGANIZATION—A convenient way to look upon the storage capabilities of MODEL 2 disc files from a programming point of view is to visualize its multiple disc surfaces in accordance with the "drum mode" concept illustrated below.

To grasp the effectiveness of this approach, consider the largest MODEL 2 file—the "C" size containing the maximum of 50 data surfaces. As illustrated, there are six read/write heads per data surface—300 heads in all—and each has access to 128 recording tracks. If the file is equipped with the new Dual/Rapid random access head positioning system, the moving heads for each module or side of the file are connected to separate actuating mechanisms. If equipped with a single access system, the heads are connected to the same actuating/positioning mechanism. Thus, when the file is requested to seek out information, all of the heads attached to the same actuating system move together—causing each of the six heads servicing a data disc surface to position over the same relative track as its counterpart servicing any other disc surface. Thus, for each of the six groups of 128 horizontally-aligned tracks across the file, there are 50 write/read heads over the same track position at any one time.

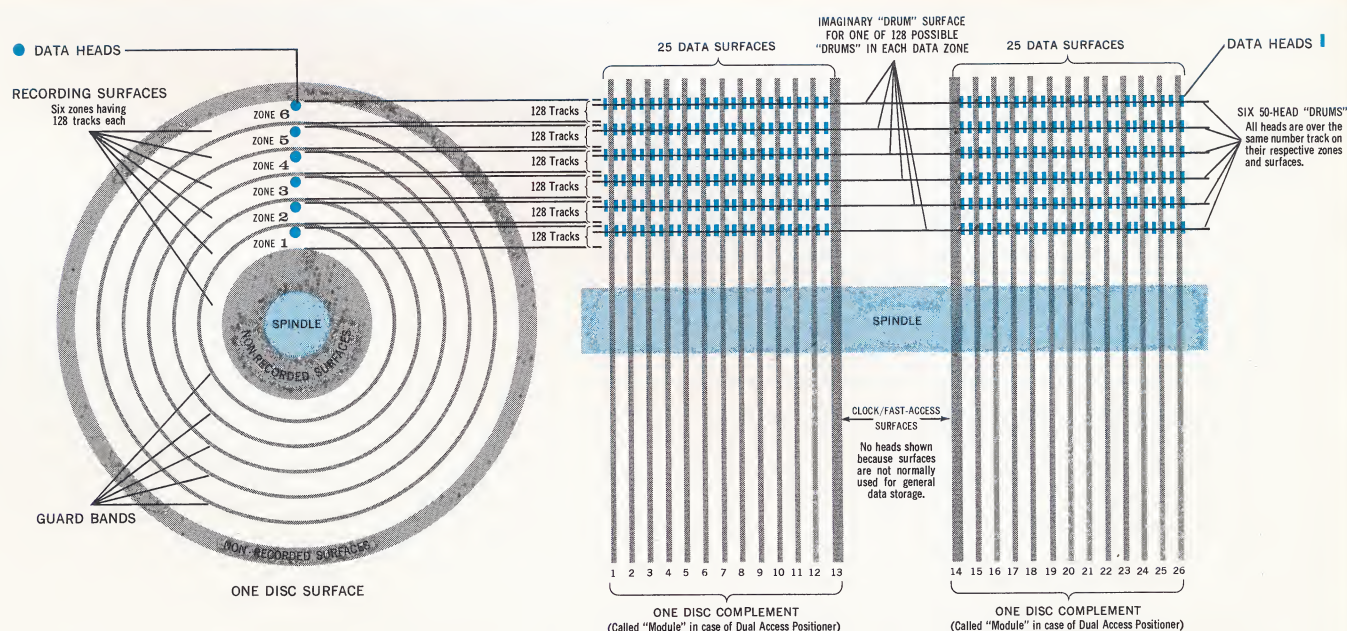
This, then, is like having six 50-head "drums"—the track length within each "drum" being the same but different from

"drum" to "drum." Thus access time can be considerably reduced by storing data in accordance with the "drum mode" concept because one instruction can cause six 50-head "drums" to spew out information simultaneously at a rate of up to 40,000 five-character words per second per track. Furthermore, because there are 128 tracks serviced by each data head, a total of 128 50-head "drums" are available for each of six different track lengths—or 768 50-head "drums" in the 26-disc file.

DUAL/RAPID RANDOM ACCESS—Conventionally, computer and edp programmers think of a disc file as a single secondary information store. With the new Bryant Dual/Rapid random access system, however, the bank of heads servicing each module or side of the file can be operated independently. Thus there are literally no restrictions on using the two file modules. One head positioning system can be used to select tracks in a random mode while the other is selecting tracks sequentially. One module of the file can be used with one computer while the other works simultaneously with another computer. Also, both modules of the file can be programmed for use with the same computer by alternately reading or writing on one side and then reading or writing on the other—a programming scheme that can reduce access time by as much as 50% over files equipped with a single random access head positioner.

PROGRAMMING FLEXIBILITY—Data organization within the 768 recording tracks per disc surface is completely unrestricted. Tracks can be divided into equal record lengths or programmed to accept records of varying lengths in either sequential or random form. Thus each user can create the pattern for storing data on a track and establish requirements according to his particular needs.

To take full advantage of the Bryant Dual/Rapid access system,



EXPLANATION—For any given head position, there are six 50-head "drums" in operation. Each "drum" services tracks which are the same length. However, one "drum" has different length tracks in it than does the

other five. □ There are 128 positions (tracks) to which the head can be positioned. Thus there are a total of 768 50-head "drums" possible. □ Each annular zone across the whole file contains 128 50-head "drums."

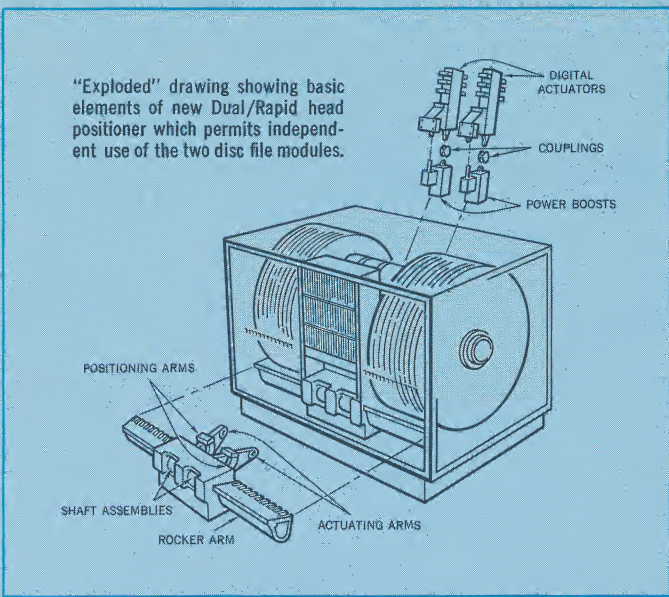
however, data format should be planned in accordance with the "drum mode" concept. Records of different lengths can be intermixed through variable format control. Depending on the application, the file can be loaded in a purely random manner or on a partial for fully sequential basis.

Many disc file applications can take advantage of block formatting — a technique for transferring a block of data into and out of a memory in either a sequential or a random mode. Using this approach, all the data in a disc "drum" zone could be transferred at microsecond head switching speed before a millisecond track-to-track positioning operation is required to access a different disc "drum" zone.

Despite the advantages of block formatting, most applications require at least a partial utilization of the file's random accessing capability — that is, its means of accessing records or record sequences which are located anywhere in the file. Availability of the random access feature greatly facilitates programming of a computation, particularly in program storage, compiling, multiprogramming, real-time processing and data communications where very large transfers or dumps occur. In these applications, very high transfer rates are of utmost importance — as are short access times.

Each of the two disc surfaces reserved for clock, track verification and fast access data are serviced by sixteen, non-positioning magnetic heads. Because these heads are fixed in place and therefore can write and read on only one track each, they are capable of retrieving high priority data in the average rotational latency time of the disc—or 25 milliseconds for 1,200 rpm files and 33 milliseconds for 900 rpm files. Usually, four of these heads on each clock surface are assigned to clocking functions, leaving the other 12 heads on each clock surface for use at the customer's option. Thus, 24 tracks are normally available in a file to provide up to 1,217,880 bits (or 152,235 bytes) of storage for fast access data.

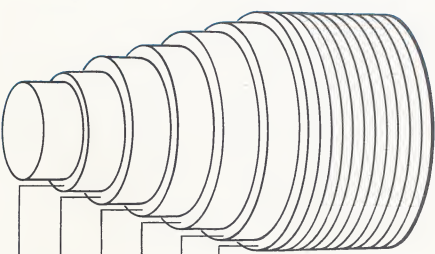
Through the use of fast access indexing tracks located on the two clock surfaces, full advantage can be taken of the high

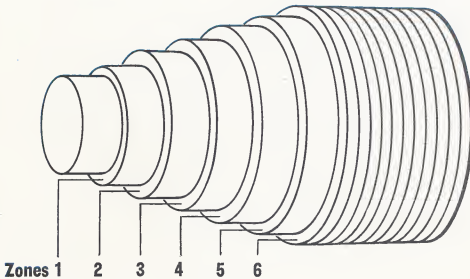


transfer rates afforded by sequential recording. These control signals ensure that the data are recorded accurately and that the correct record is selected for transferring data between the disc file and other computer storage during writing and reading operations. Discrete bit clocks, character clocks, word marks, sector pulses and address data can be recorded by the user on the clock discs or—if desired—prerecorded by Bryant to meet the user's requirements.

Ultra reliable parallel outputting can be affected with single and dual access MODEL 2 files with an extraordinarily low error rate of one recoverable error in 10¹¹ bits processed. A single strobe for each access of a file is all that is required for parallel reading. When operating a file in the parallel mode, de-skewing buffers must be used in order to achieve full recording densities.

IV—"Drum Mode" Capacities for Bryant Model 2 Series 4000-C Disc File
1200 rpm, 50 Data Surfaces, 600 bpi Track Density

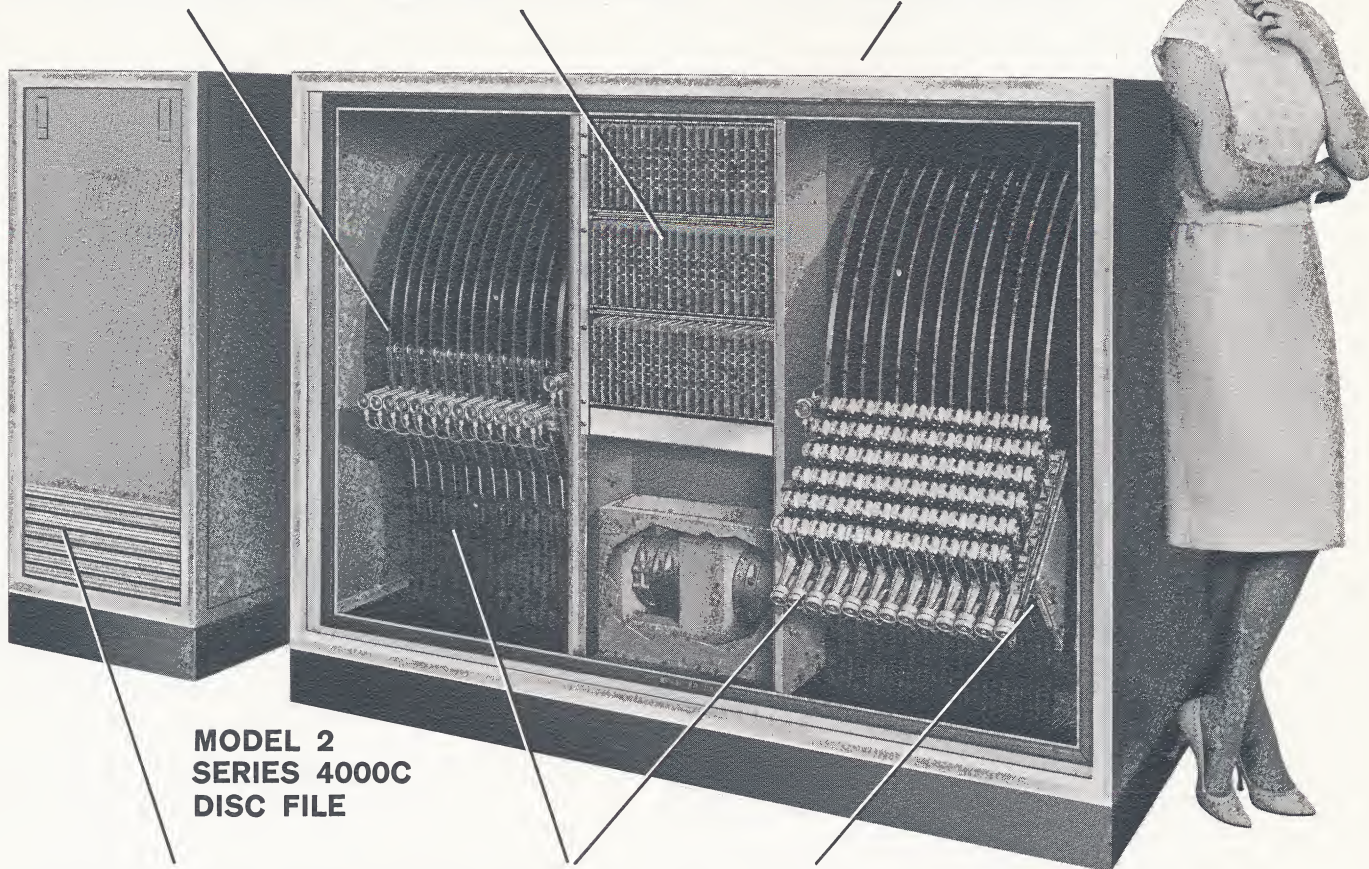
							6-FREQUENCY 6-ZONE FORMAT		2-FREQUENCY 6-ZONE FORMAT		1-FREQUENCY 4-ZONE FORMAT			
Disc “Drum” Zones	Recording Frequency	Write/Read Rate		Max. Track Capacity		Data Heads Per “Drum” Cylinder	Capacity per “Drum” Cylinder		Capacity per “Drum” Cylinder		Capacity per “Drum Cylinder			
		Bits/Sec.	Bytes/Sec.	Bits	Bytes		Max. Bits	Max. Bytes	Max. Bits	Max. Bytes	Max. Bits	Max. Bytes		
(Inner)														
1	458 kc	458,000	57,250	22,910	2,864	50	1,145,500	143,187	1,145,500	143,187	(Not Used)	(Not Used)		
2	617 kc	617,000	77,125	30,832	3,854	50	1,541,600	192,700	1,145,500	143,187	(Not Used)	(Not Used)		
3	776 kc	776,000	97,000	38,791	4,849	50	1,939,550	242,444	1,939,550	242,444	1,939,550	242,444		
4	935 kc	935,000	116,875	46,750	5,844	50	2,337,500	292,187	1,939,550	242,444	1,939,550	242,444		
5	1,095 kc	1,095,000	136,875	54,731	6,841	50	2,736,550	342,069	1,939,550	242,444	1,939,550	242,444		
6	1,254 kc	1,254,000	156,750	62,708	7,839	50	3,135,400	391,925	1,939,550	242,444	1,939,550	242,444		
(Outer)														
							Totals:	12,836,100	1,604,512	10,049,200	1,256,150	7,758,200	969,776	
							Disc “Drum” Zones	Capacity per Zone of “Drum” Cylinders		Capacity per Zone of “Drum” Cylinders		Capacity per Zone of “Drum” Cylinders		
								Max. Bits	Max. Bytes	Max. Bits	Max. Bytes	Max. Bits	Max. Bytes	
							(Inner)							
							1	146,624,000	18,328,000	146,624,000	18,328,000	(Not Used)	(Not Used)	
							2	197,324,800	24,665,600	146,624,000	18,328,000	(Not Used)	(Not Used)	
							3	248,262,400	31,032,800	248,262,400	31,032,800	248,262,400	31,032,800	
							4	299,200,000	37,400,000	248,262,400	31,032,800	248,262,400	31,032,800	
							5	350,278,400	43,784,800	248,262,400	31,032,800	248,262,400	31,032,800	
6	401,331,200	50,166,400	248,262,400	31,032,800	248,262,400	31,032,800								
(Outer)														
							Totals:	1,643,020,800	205,377,600	1,286,297,600	160,787,200	993,049,600	124,131,200	



High Density Recording—All MODEL 2 Series 4000 Files are capable of writing and reading back data reliably at packing densities up to a nominal 600 bits/inch when recording in phase-modulation mode. This means you can store 32,860,416 bits per data surface—or up to 1,643,020,800 bits in the 26-disc mass memory above!

Electronic Interface—Write, read, head select, and logic electronic circuit modules are mounted in hinged racks conveniently located in separate air-cooled bay accessible through center panel. Systems can be designed to meet your specific requirements with respect to data rates, control signals, capacity, and mode of operation.

Environmental Controls—All MODEL 2 disc files are equipped with an environmental control unit designed especially to minimize air contamination and maintain the proper environment for optimum file performance. Attached to rear of file, each unit provides full-flow mechanical filtration and self-contained mechanical cooling.



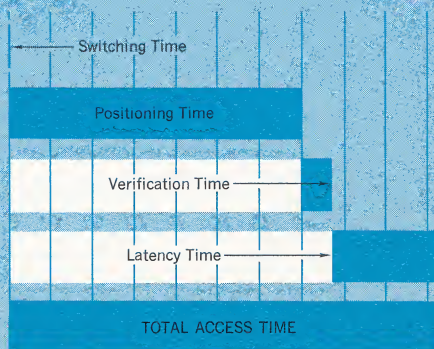
**MODEL 2
SERIES 4000C
DISC FILE**

Power Controls—Furnished in separate cabinet as shown with "C" size files and enclosed in main frame of "B" size files, this compact power control unit features point-to-point connections for all electrical, hydraulic, and pneumatic elements in accordance with recommendations of Underwriters' Laboratories, Inc.

Dual/Rapid Positioning—New rapid random-access system consists of an independent, open-loop, electrohydraulic digital head positioner for each side of the file—with each positioner controlled by separate signals. This permits use of each module as an individual memory, provides greater versatility and faster access.

Signal Preamp—Magnetic heads can terminate in a preamplifier/switching device mounted near the related head bar. Each services 12 heads and provides gain factor of approximately 5 to playback values fed to read amplifiers. This arrangement reduces cabling impedance, improves resonance frequency, minimizes noise.

**DIAGRAM BREAKING DOWN
TOTAL ACCESS TIME**



NOTE: Times listed above are based on use of 14-disc single access Model 2 Series 4000B File at 1200 rpm.

BEST CASE Sequential, Track-to-track	WORST CASE Full Stroke, Track 0 to 127 or 127 to 0
μs	μs
35 ms	140 ms
15 ms	15 ms
0 ms	50 ms
50 ms	205 ms

I—Maximum Data Storage Capacities

Disc File Size	Max. Data Surfaces		Capacity Per Module		Capacity Per File	
	Module	File	Max. Bits	Max. Bytes	Max. Bits	Max. Bytes
4000-B	13	26	427,185,408	53,398,176	854,370,816	106,796,352
4000-C	25	50	821,510,400	102,688,800	1,643,020,800	205,377,600

II—Maximum Positioning Times*

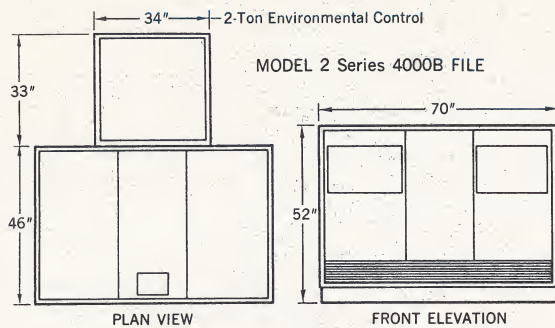
Type of Access	Discs Per Positioner	Maximum Time
Single	1 to 8	120 ms
	9 to 14	140 ms
	15 to 26	165 ms
Dual/Rapid	1 to 8	160 ms
	9 to 13	180 ms

*Positioning time is defined as time from instant of track selection until selected track is reached and playback signal amplitude is at full minimum value continuously.

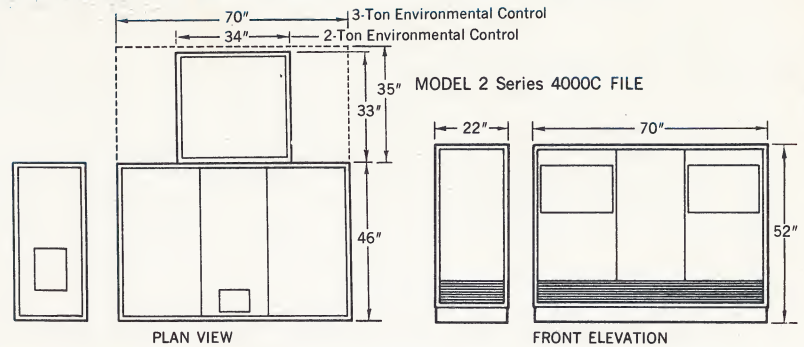
III—Dual File Positioning Rates

Positioning Mode	Maximum Positionings	
	1 Module Alone	Simul- taneous
Random	7/second	5/second
Full stroke (0 to 127 tracks, 127 to 0 tracks)	6/second	4/second
Sequential (track-to-track)	10/second	10/second

PHYSICAL SPECIFICATIONS/MODEL 2 SERIES 4000 DISC FILES



Weight of main frame with full complement of 14 discs:
Shipping—3321 pounds. Installed—3044 pounds.



Weight of main frame with full complement of 26 discs plus power control unit:
Shipping—3944 pounds. Installed—3551 pounds.

Note—Subtract 33 pounds per disc assembly—including rocker arm and head bar—for files with fewer than maximum number of discs.

V—CHARACTERISTICS OF BRYANT MODEL 2 SERIES 4000 DISC FILES

PARAMETER	MODEL 2 SERIES 4000B	MODEL 2 SERIES 4000C
Disc diameter	39 inches	39 inches
Data zones per disc surface	6	6
Data tracks—per radial inch	65, nominal	65, nominal
—per zone	128	128
—per surface	768	768
Discs per file	14 max.	26 max.
Data surfaces—per module	13 max.	25 max.
—per file	26 max.	50 max.
Clock/fast-access surfaces	2 per file	2 per file
Bit capacity—per disc surface	32,860,416 max.	32,860,416 max.
—per module	427,185,408 max.	821,510,400 max.
—per file	854,370,816 max.	1,643,020,800 max.
*Byte capacity—per disc surface	4,107,552 max.	4,107,552 max.
—per module	53,398,176 max.	102,688,800 max.
—per file	106,796,352 max.	205,377,600 max.
Data heads—per surface	6 max.	6 max.
—per module	78 max.	150 max.
—per file	156 max.	300 max.
Tracks serviced per data head	128	128
Clock/fast-access head pads	8 per surface	8 per surface
Clock/fast-access heads per pad	2	2
Clock heads—per surface	4	4
—per file	8	8
Fast-access heads—per surface	12	12
—per file	24	24

PARAMETER	MODEL 2 SERIES 4000B	MODEL 2 SERIES 4000C
Head positioners—single access	1 per file	1 per file
—Dual/Rapid access	2 per file	2 per file
Positioning time	(See Table II)	(See Table II)
Positioning rate	(See Table III)	(See Table III)
Rotational speeds	900 rpm or 1200 rpm	900 rpm or 1200 rpm
Latency time—at 900 rpm	33 ms (average)	33 ms (average)
—at 1200 rpm	25 ms (average)	25 ms (average)
Power requirements—at 900 rpm	†208-volt, 3-phase 60-cycle, 12.2 KVA source for 14 discs	†208-volt, 3-phase 60-cycle, 18 KVA source for 26 discs
—at 1200 rpm	†208-volt, 3-phase 60-cycle, 14.6 KVA source for 14 discs	†440-volt, 3-phase 60-cycle, 20 KVA source for 26 discs
Recommended recording scheme	Phase modulation with self-clocking	Phase modulation with self-clocking
Recording frequencies	Up to 1.254 Mc per sec (See Table IV)	Up to 1.254 Mc per sec. (See Table IV)
Recording current per half coil	150 ma	150 ma
Preamplifier gain factor	5 (approximate)	5 (approximate)
Warm-up time—self-clocked	Virtually instantaneous	Virtually instantaneous
—fully-clocked	Less than 15 minutes	Less than 15 minutes
Ambient temperature range— —non-operating	—30° to +130°F	—30° to +130°F
—operating	60° to 100°F	60° to 100°F
Ambient humidity range—operating	10 to 80% relative	10 to 80% relative
Dirt control rating	95% N.B.S.**	95% N.B.S.**

*Byte capacities based on 8 bits per byte. □ **National Bureau of Standards Rating means that the main filter is 93 to 97% efficient at one micron dust levels.
†Includes power for 2-ton environmental control unit. □ ††Includes power for 3-ton environmental control unit.

BRYANT "TOTAL PRODUCT ASSURANCE" CONCEPT

One reason why Bryant has become the world's leading independent producer of disc files and memory drums is its concept of "total product assurance." For when you buy Bryant equipment, you can be sure that:

- 1) It's design is based upon proven principles of operation and performance.
- 2) Every outside purchased component is the very finest obtainable.
- 3) Every precision part and assembly is controlled to the highest known standard of accuracy and quality. And 4) every finished product has been subjected to thorough computer-simulated testing prior to shipment to assure the ultimate in value and reliability.

Other Bryant customer services include complete installation of equipment by qualified factory engineers, a special training school for instruction of your personnel, and an inventory of spare parts—many having assigned federal stock numbers—to assure prompt field replacements when necessary.

**BRYANT
COMPUTER PRODUCTS**



EX-CELL-O CORPORATION

BRYANT COMPUTER PRODUCTS

850 LADD ROAD □ WALLED LAKE, MICHIGAN 48088

□ Telephone 313/624-4571 □ TWX 810/231-7190

NEW!